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EDITORIAL

An Alibi Disappears

For some time now we have advocated better materials engineering both by editorial expressions and by supplying the kind of information materials engineers need. Much of the effort was made with the realization that little could be done about it at the moment. Our advice and help was for the future.

The future we had in mind now appears to be here. With available goods catching up with demand in many fields, we have seen an over-night change in the supply of engineering materials. With one or two exceptions, particularly in metals, supplies are ample or will be in the forseeable future. That this condition is more than wishful thinking is proved by recent drops in metal prices.

So there now disappears a convenient alibi which was used to explain poor merchandise. We have all suffered from it in our private lives, if not in our business activities. It is our opinion that widely publicized materials shortages were often used to camouflage laziness, avarice or lack of knowledge.

Of the three possible reasons, laziness—or lethargy—is probably the biggest culprit. Unfortunately, it is rare that one material can be replaced by another without making some engineering changes. That is, changes in design, processing, finishing or something must be made to take full advantage of the newer material.

Now, it would seem, is the time for the materials engineer, or anyone else charged with selecting and specifying materials, to prove his worth. Sooner or later the complaints which the public has on its mind will come home to the manufacturer. The complaints can take any form, but the most common—and most damaging—is the withholding of business. Eventually the materials man will be drawn into the picture.

If he is on his toes, the materials engineer will have developed what he considers sound materials suggestions and have them ready before he is asked. However, his own convictions will mean little unless he backs them up with convincing data proving lower cost, higher production, longer life, better appearance, or any other desirable improvement.

If on top of being a good engineer, he is a good salesman, our materials man might even sell his ideas for product improvement to his management. That could be one way of demonstrating the value of having materials engineers and prove that this type man can do more than make metallographic studies and prepare specification sheets.

T. C. Du Mond
Editor

If Alloys Could Talk...

If alloys could talk—could correctly identify themselves, state their hardenability, their mechanical properties and their best working temperatures—the tasks of specifying, buying and heat treating would be greatly simplified and virtually mistake-proof.

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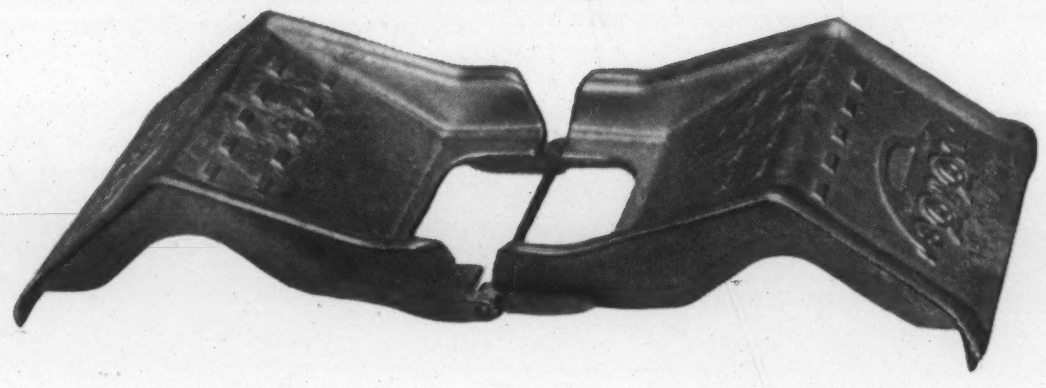
Fig. 1—This magnesium alloy casting is used under wheels to prevent rolling when changing tires.



Magnesium Die Castings Offer Weight Saving and Low Cost Advantages

by R. C. CORNELL, Vice President, Litemetal Dicast, Inc.

The case for die castings of magnesium as compared to those of aluminum and zinc is presented through descriptions of applications in which all three were considered.

• ONE OF THE PRINCIPAL drawbacks to a more widespread use of magnesium alloy die castings has been their relatively high cost. The experience of Litemetal Dicast, Inc., however, has shown that for many uses magnesium die castings can be produced at a favorable cost as compared to die castings of aluminum and zinc. Besides cost there are, of course, other factors, such as casting properties, weight and performance, that must be considered in arriving at a proper selection. And in many cases, magnesium is also a favorable choice on the basis of these.

From a casting standpoint, the company prefers magnesium to aluminum alloys for the following reasons: castings can be produced, in general, about 20% faster, partly because less heat has to be absorbed and the die can be opened sooner after filling. Ejection of the casting is easier, the metal being more slippery and free from the tendency to stick to cores or "solder" to the die, as is often the case with aluminum.

As opposed to this, there is some tendency with magnesium to surface cracking. Surface imperfections may run higher and there may be more

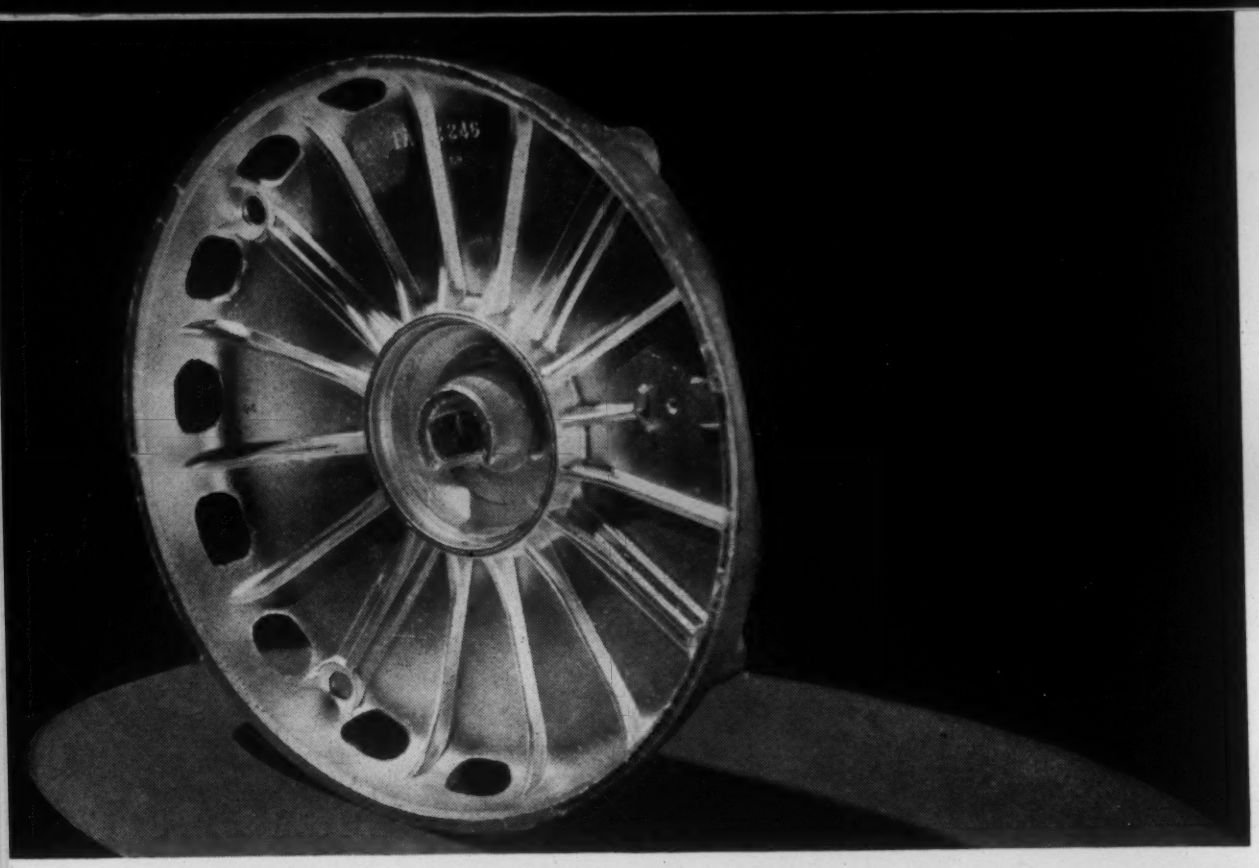


Fig. 2—End bells for a fractional-horsepower motor. They would cast 15% faster and cost about 8c less per casting than in aluminum alloy.

Fig. 3—For this field ring, the die casting rate in magnesium was 20% faster than in aluminum.

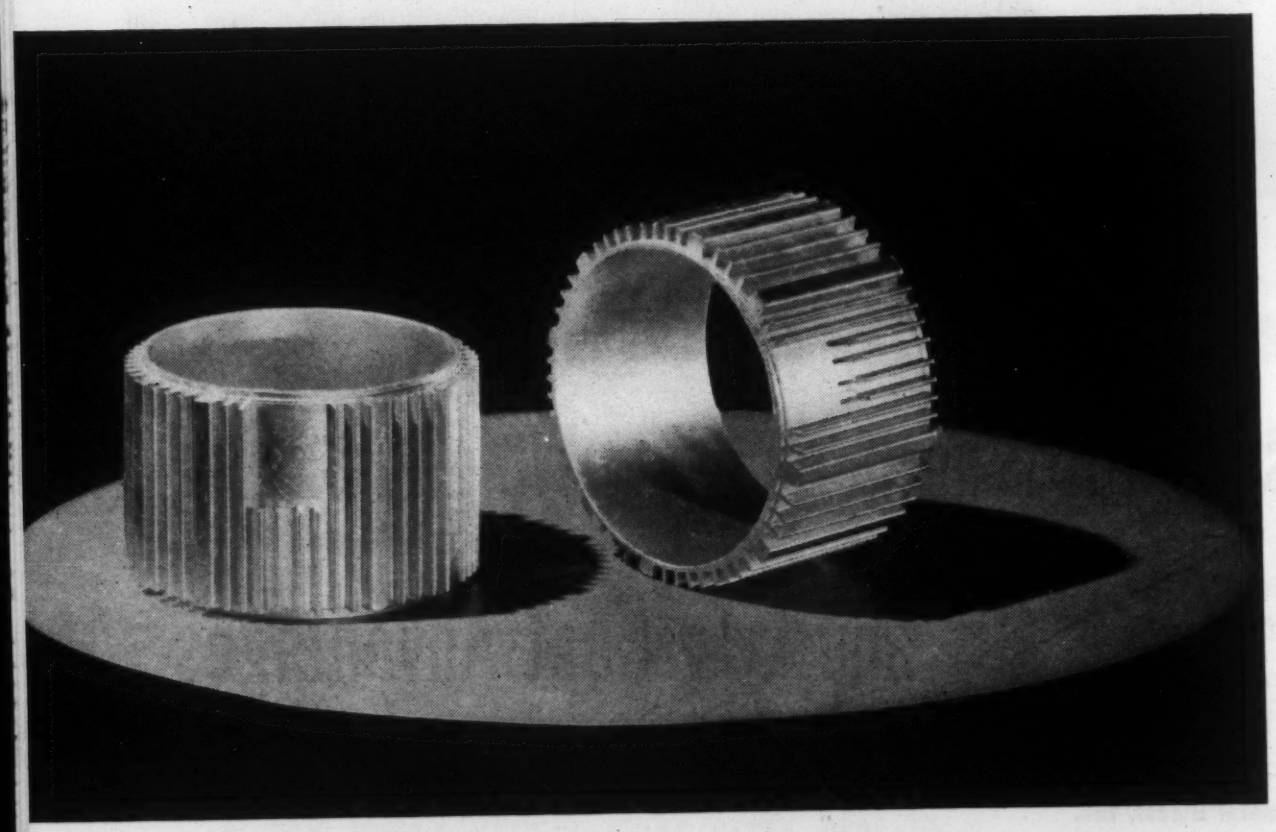
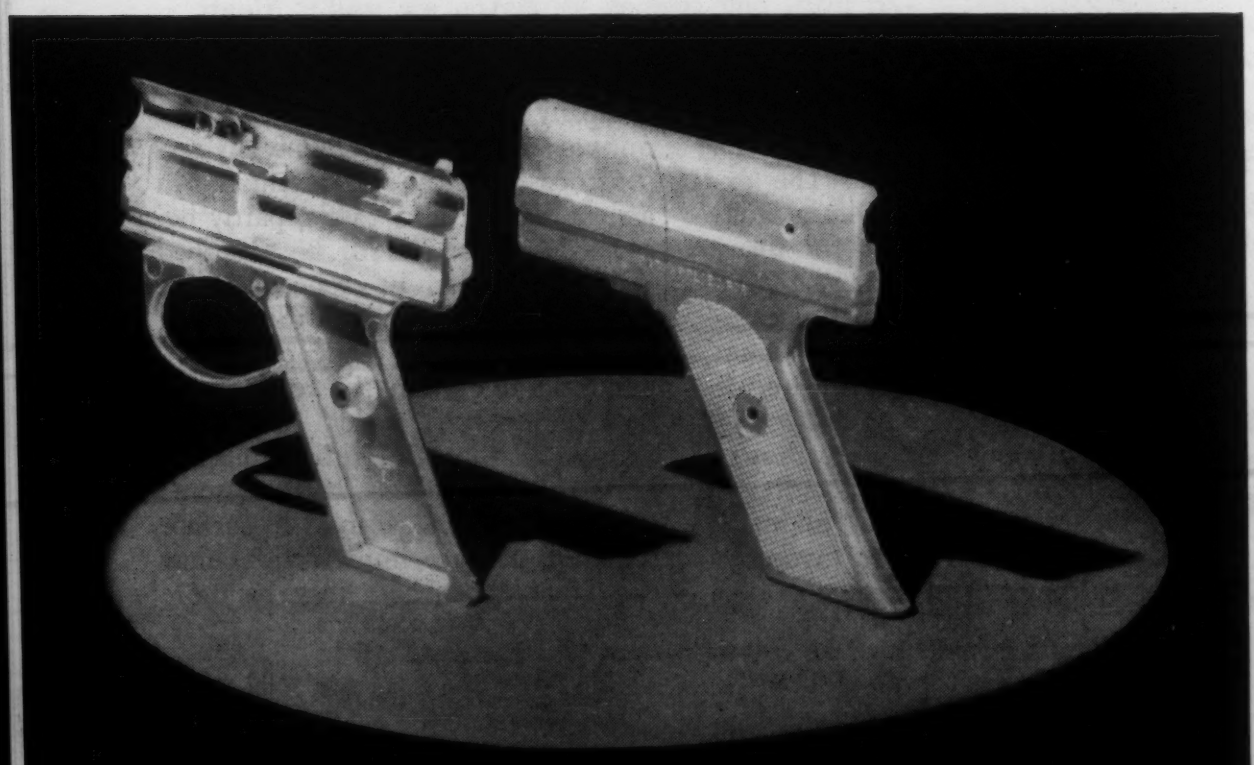


Fig. 4—Although these toy pistol parts cost less when die cast in magnesium than in aluminum alloy, the latter was used because no applied finish was required.



castings rejected for failure to fill out. Thus, average rejects may run about 4% with aluminum as against perhaps 10% with magnesium. Melting losses and flux costs are also higher for magnesium and higher injection pressures and injection speeds are commonly needed. Thus, pressures for aluminum are commonly 3,000 to 15,000 psi. and for magnesium 3,000 to 50,000 psi. Injection speeds for aluminum generally are 20 to 100 ft. per min. and for magnesium 60 to 600 maximum, as applied to the injection ram.

It is important that the machine used be well adapted to the metal. Those well suited for magnesium can be used for aluminum, though the reverse is not always true. Generally, a heavier machine is required for magnesium, but the same dies can be and often are used unless they happen to be made unusually light and so are not adaptable to the higher pressures for magnesium.

Allowance for shrinkage is about the same for aluminum and for magnesium (0.006 in. per in.); this is greater than that for zinc. For this reason and others, dies well suited for zinc generally are not usable for magnesium or aluminum. Such considerations often have a bearing upon the feasibility of shifts from one alloy to another in the same die.

Following are a number of case histories that should serve to compare die castings made of the three different materials. Where relative costs are given, they are based on *per pound* costs existing at the time the comparisons were made. These are as follows: aluminum alloy (ASTM SC6) 24¢; magnesium alloy (ASTM AZ 91) 23¢; zinc alloy (ASTM XXIII) 18¾¢. It is significant, of course, that magnesium weighs 0.066 lb. per cu. in., or one-third less than aluminum (0.099 lb. per cu. in.) and about one-fourth as much as zinc alloy (0.24 lb. per cu. in.). There are differences in strength, of course, but, if comparisons are made among castings having the same dimensions, including wall thickness, as is generally the case, the cost of metal only is greatly in favor of magnesium alloy. The smaller the casting, however, the less is the advantage in low metal costs per casting.

Magnesium Die Castings Save Weight

The no-roll castings, Fig. 1, for use in changing car or truck tires, could be cast 26% faster in magnesium

than in aluminum. Castings weigh 2.4 lb. each in aluminum and 1.8 lb. in magnesium, and the price of the latter was 27% lower. As the parts are carried about and often lifted, the lighter weight of the magnesium is a definite advantage.

Fractional horsepower motor end bells, Fig. 2, weigh 0.75 lb. in aluminum, 0.5 lb. in magnesium. The magnesium part was 15% faster to cast and this, together with saving in metal cost, permitted a price per casting nearly 25% lower in magnesium. Weight figures for the field ring, Fig. 3, are the same as those given for the motor end bells but, in this case, although casting was 20% faster in magnesium, the price per piece was only 20% lower, though still significant.

Toy pistol castings, Fig. 4, produced in both aluminum and magnesium weigh 0.49 lb. per set in aluminum and 0.32 lb. in magnesium. The latter proved to be a full 40% faster to produce. This resulted in a price 23% lower for the magnesium set, but production reverted to aluminum because the magnesium castings had to be painted while those in aluminum could be given a bright tumbling finish in bulk at low cost.

Spools for Wire and Textiles

In Fig. 5 is shown a spool on which wire is wound and shipped. This spool is produced as a one-piece magnesium die casting that weighs 0.49 lb. as against 0.72 lb. for aluminum, called for in the original specification. Cost saving to the customer amounted to 40%, partly because the casting rate is 50% faster and the metal cost is lower. As a part of this shape requires a pair of slides in the die and these leave a parting line that must be removed, the inside flange faces and outer diameter of the tube have to be machined. This is done in an automatic lathe and, because magnesium can be machined faster and more easily than aluminum, the cost saving on this work is estimated at about 1¢ per piece. The purchaser saves also on shipping costs both on castings received and on outgoing shipments; this saving is realized in all cases where magnesium is chosen over heavier metals.

Somewhat similar conditions apply to spools or bobbins for textile applications, of which millions have been die cast by this company. Costs run well below those for aluminum and, in some cases, no machining is required. An advantage for the magnesium is that it avoids the tendency

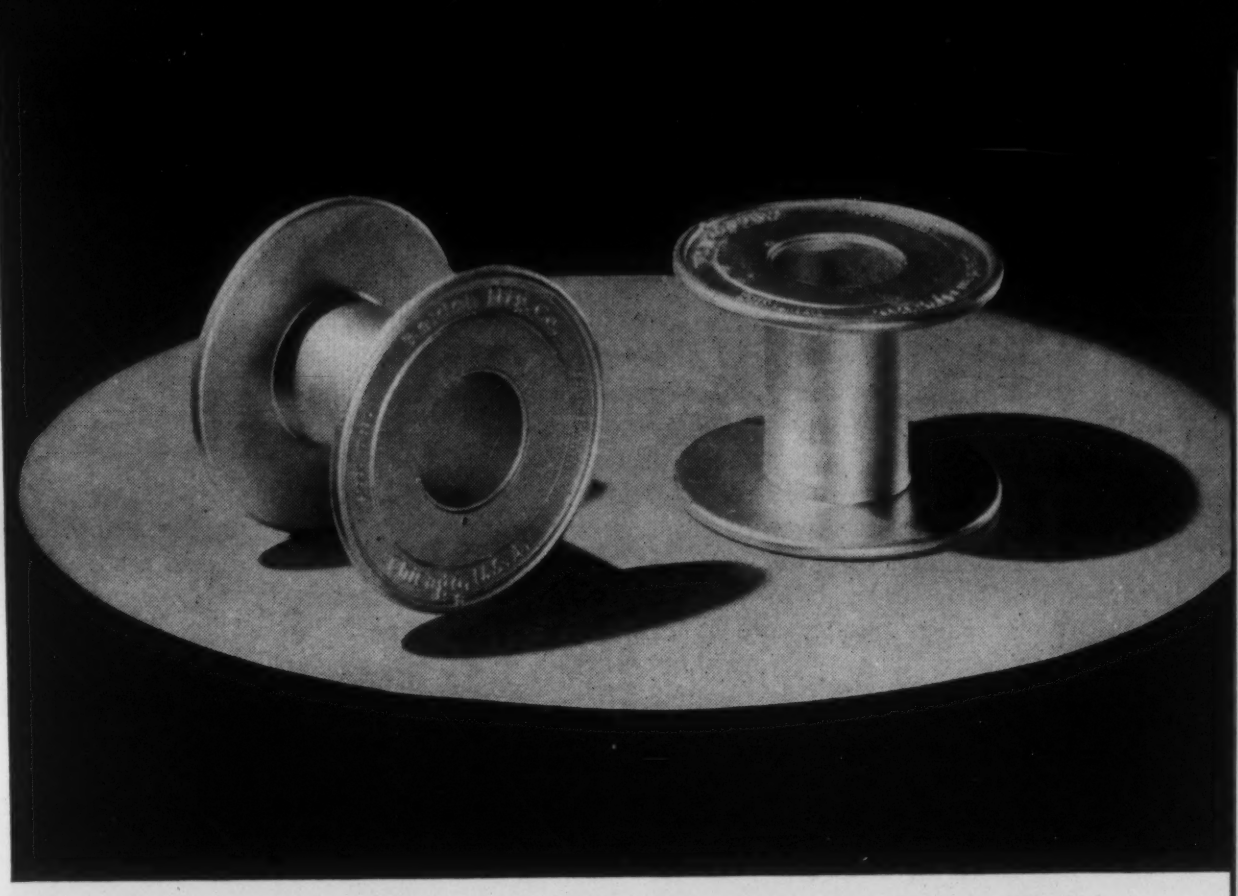


Fig. 5—Spools on which wire is wound and shipped. Die casting in magnesium is 50% faster than in aluminum.

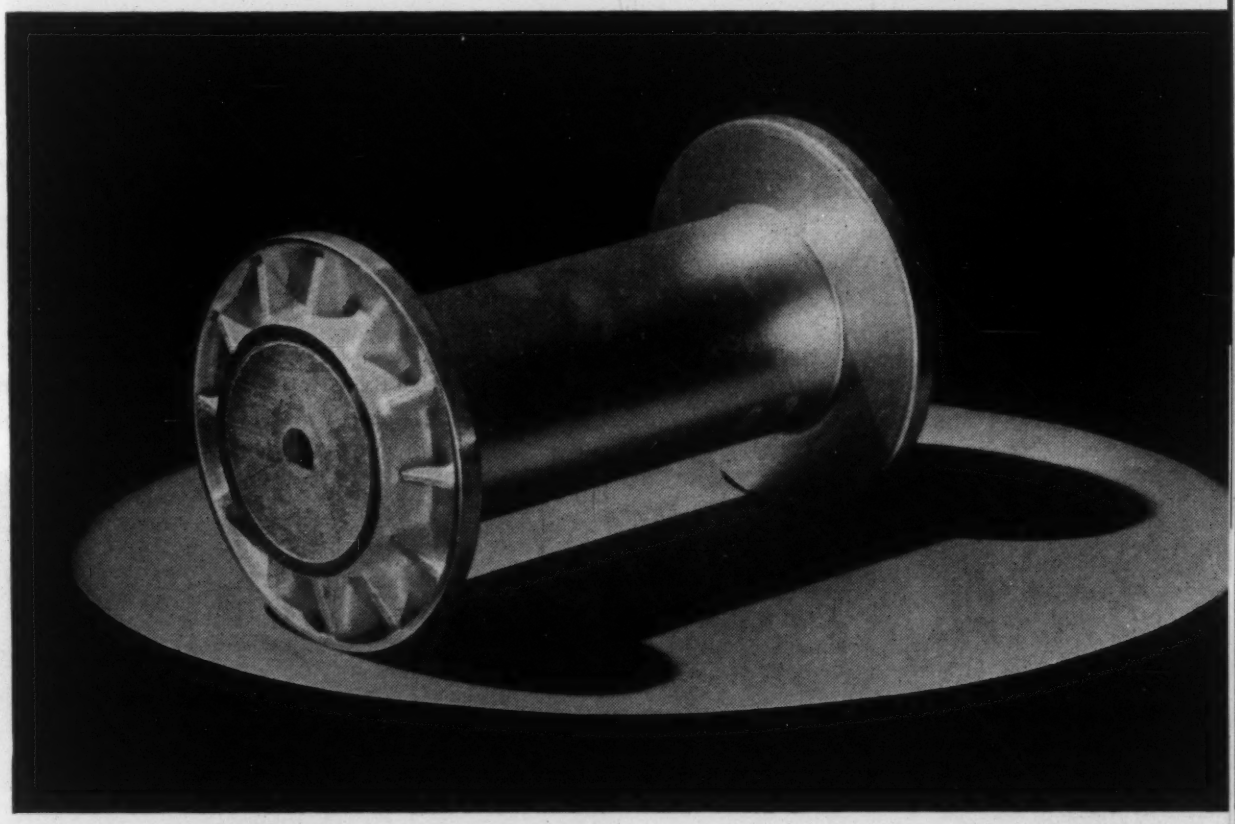
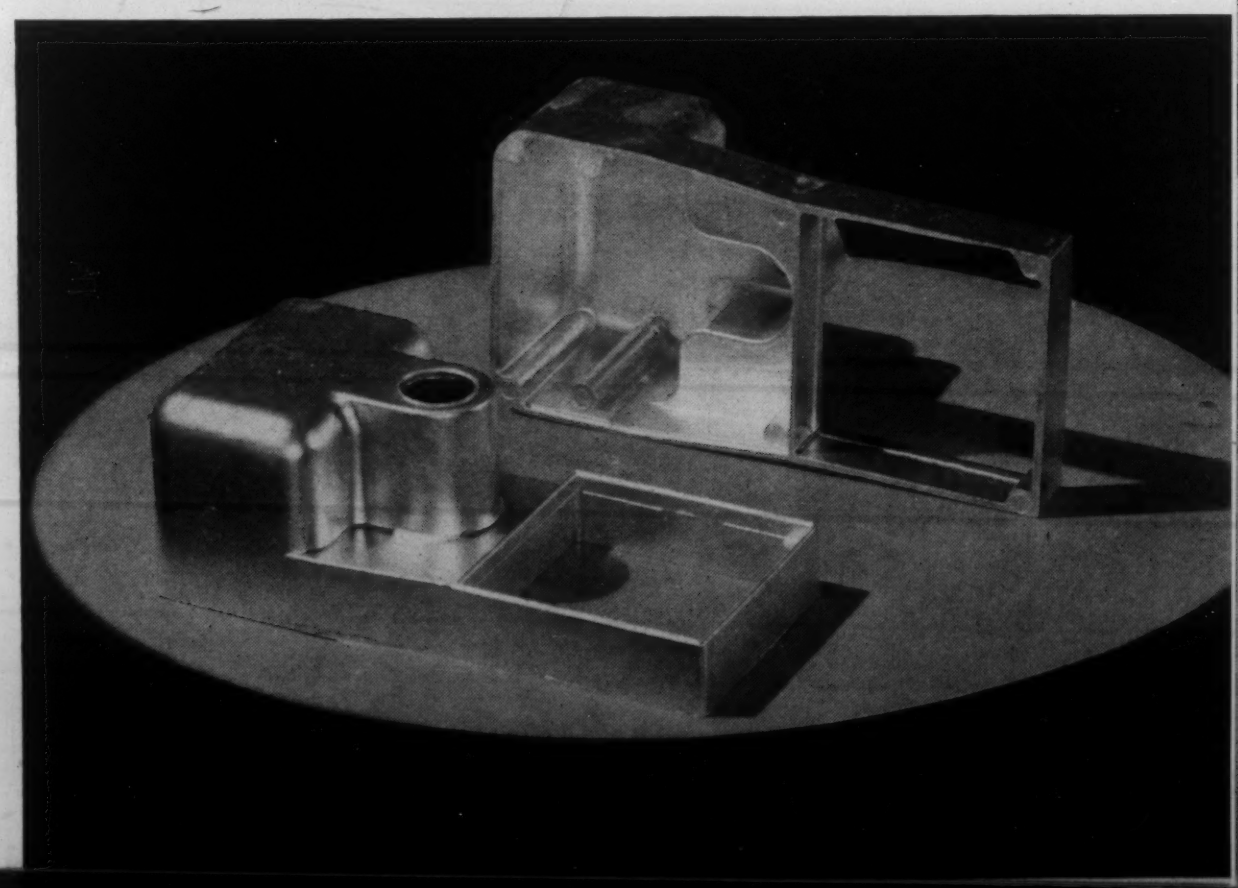


Fig. 6—One of many magnesium die cast spools or bobbins preferred over aluminum equivalents because lower in cost and better on other scores.

Fig. 7—Two views of a magnesium die cast frame for a desk lighter.



to discolor fine filaments where they contact the metal. Discoloration sometimes occurs with aluminum. It is also easier to provide smoother surfaces where machining is required because the magnesium cuts so freely.

One of many spools used for textile work is shown in Fig. 6. This magnesium casting weighs 2.5 lb. and measures 9 in. long. Flanges are 5½ in. in dia. The bore is cored, of course, and a long core is needed. Such cores become very hot with aluminum but run much cooler with magnesium, because its heat content is so much lower. This accounts in part for a 20% faster casting cycle; there is also less trouble from sticking on cores. Price per piece is 21% lower for magnesium than for aluminum.

Another type of spool is that used on wire recorders. One machine of this type uses a ribbed drum of 6½ in. O.D., which has been produced in both aluminum and zinc alloys at about equal cost. Lower metal cost for aluminum apparently is offset by the higher casting rate feasible with zinc alloy. In this instance, the die used for zinc could be used also for aluminum, but was not strong enough for the pressures required for magnesium. As the drum has to be stopped and accelerated quickly and often, low inertia favors magnesium. However, it has not been used, despite lower estimated cost per casting, because a new die would be needed. Aluminum proved satisfactory and did not require the applied finish essential on magnesium.

For the casting used as a frame for a desk-type cigar lighter and shown from both sides in Fig. 7, magnesium has been chosen over aluminum largely because casting is 17% faster and the lower metal costs permit a saving of 7½¢ per piece, or nearly 20%. In such products, a "hammertone" or similar finish can be used and provides an attractive appearance.

Other Typical Cases

An interesting case is that of a casting for a home workshop band saw frame having maximum dimensions of 35¼ by 16⅜ in. Average section thickness approximates 3/16 in. The die will be made for casting in aluminum. Weight per casting will approximate 12 lb. This is an unusually large casting for magnesium, but it is believed that it can be made in magnesium and at a rate about 25% faster than for aluminum (though production in this form has not been guaranteed). If casting in magnesium proves successful, however, the price tentatively quoted is $1.20 less per casting than for aluminum. In this event the customer will save also in freight and probably on machining, though little of the latter is needed.

Many gear-type oil pumps for automotive engines have been produced as zinc die castings and applied with a large measure of success. But, in some cases, faces of castings in contact with sides (or ends) of the steel spur gears have suffered scuffing or galling. The metal picked up sometimes wears an annular groove in the cast face, and pumps do not function as required. It is reported that similar pumps, but having housings die cast in magnesium alloy, were used on nearly all German cars and trucks as well as on some German aircraft engines before and during the recent war. It is also stated that no scuffing occurs on such castings.

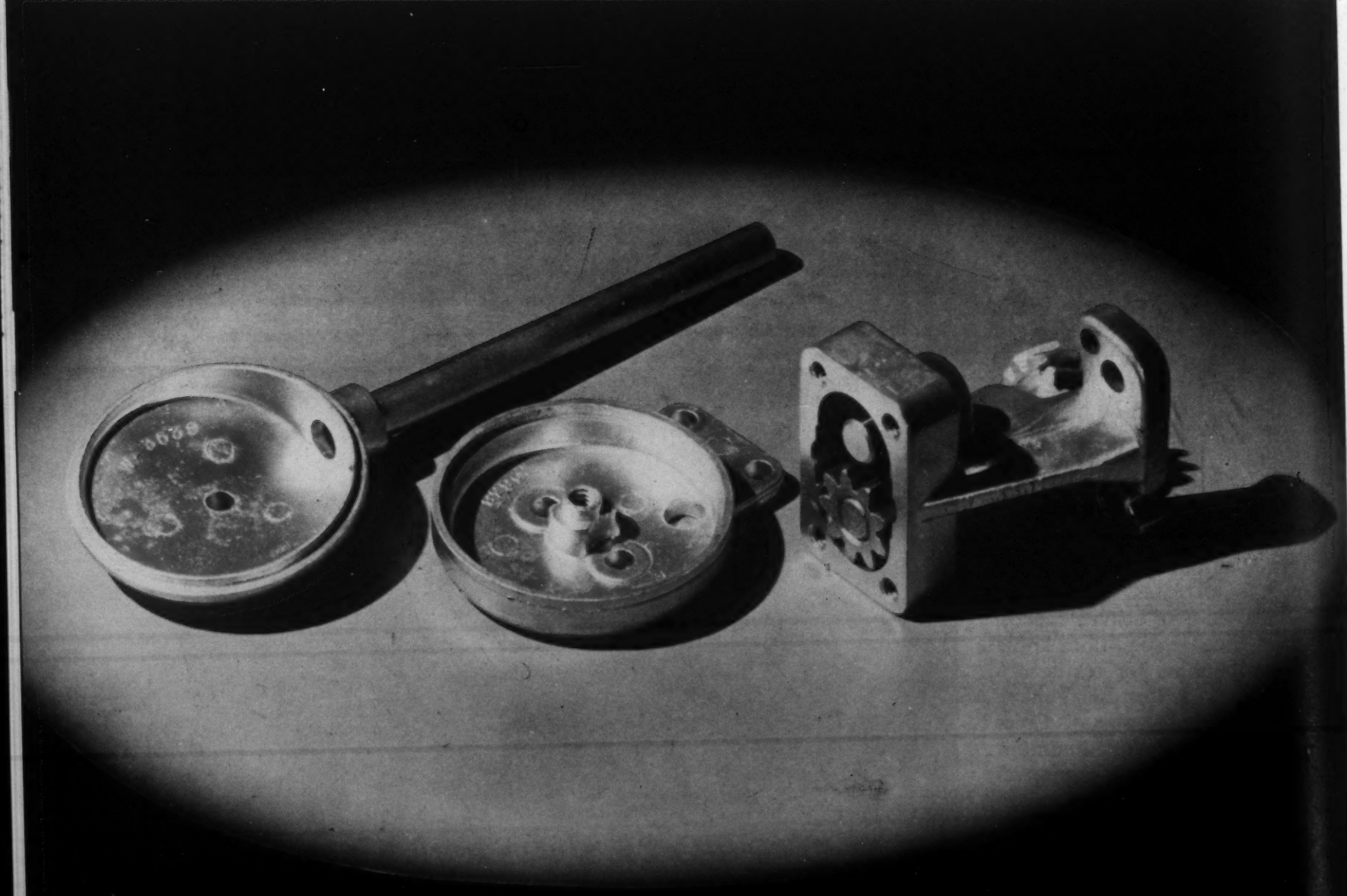
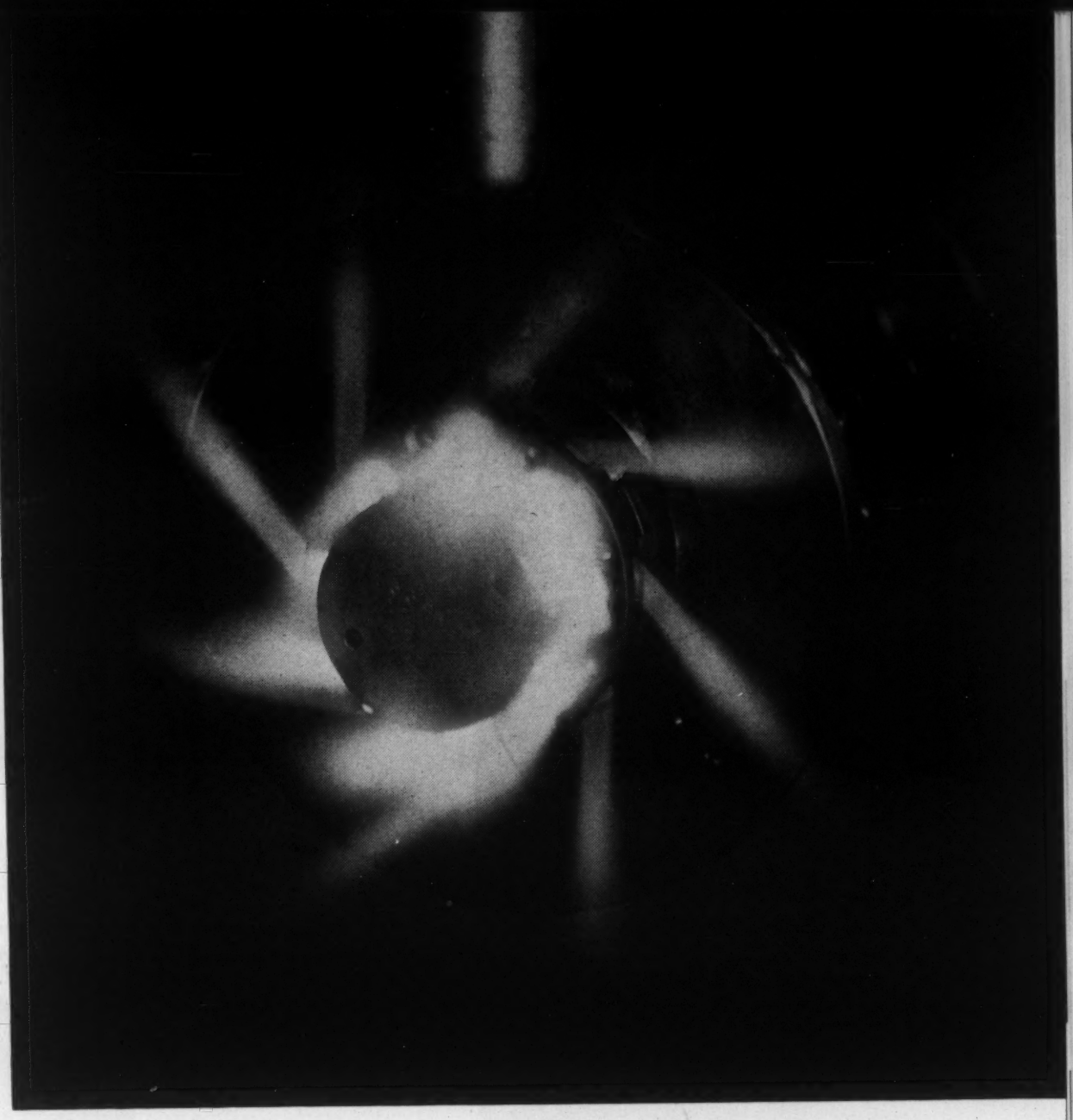


Fig 8—These three die castings would be produced at about the same price in zinc and in aluminum alloys. However, a price reduction of about 12% is anticipated through conversion to magnesium.



A cam ring undergoing localized heating.

Automatic Flame Hardening Steps Up Production of Steel Cams

The technique used and the results obtained in these cam rings point-up the advantages of localized hardening with automatic flame machines.

by HERBERT CHASE

• AMONG THE DIFFICULT PARTS to process in Buick's Dynaflow torque converter is a cam ring having eight internal recesses, the inclined surfaces which must be hardened while adjacent areas must remain soft. Local hardness must be sufficient to resist the high pressure of overriding clutch rollers, but if the hardness extends into adjacent areas, especially around holes drilled at right angles near the incline, cracking of the ring in service may result.

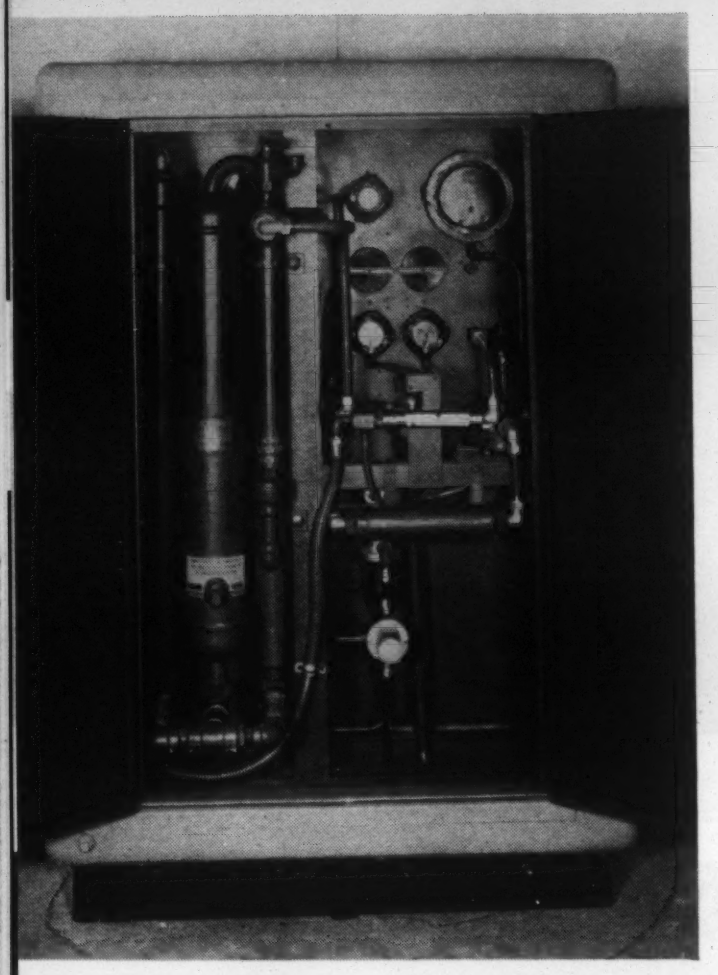
For about a year, the localized heating of the critical areas shown in the accompanying sketch of the part was done on three 20-kw. induction heating machines. Each of these had indexing fixtures and two hairpin heating coils. The latter had to be quite small to enter the spaces in which they fitted, and because of their size could not be made very sturdy. Considerable trouble was encountered in holding the coils in such position that heating was uniform and confined to the areas required. This was not a fault of the machines themselves. Trouble arose in keeping the coils and indexing equipment, designed to work automatically, set and operating as required.

As only two areas could be heated at a time, each ring had to be indexed four times to complete the entire hardening operation. Therefore, it required three machines, loaded in rotation by one man, to secure a production of 60 rings an hr. Because of this and the high percentage of rejects, another method of hardening was sought.

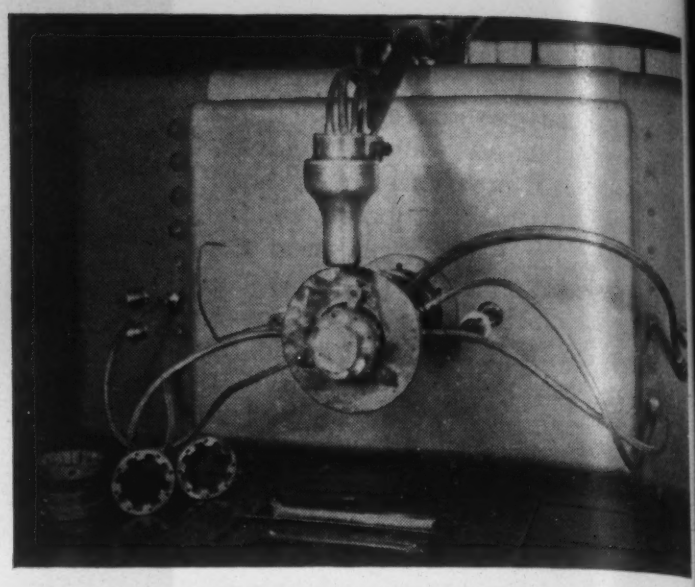
A shift to localized flame hardening was considered and, after much experimental work, it was found that the job could be done with satisfactory results by correct application of the Cincinnati "Flamatic" hardening machine. In this machine, the heating is done with gas flames whose location, adjustment and heating effects are precisely controlled.

The Flame Hardening Equipment

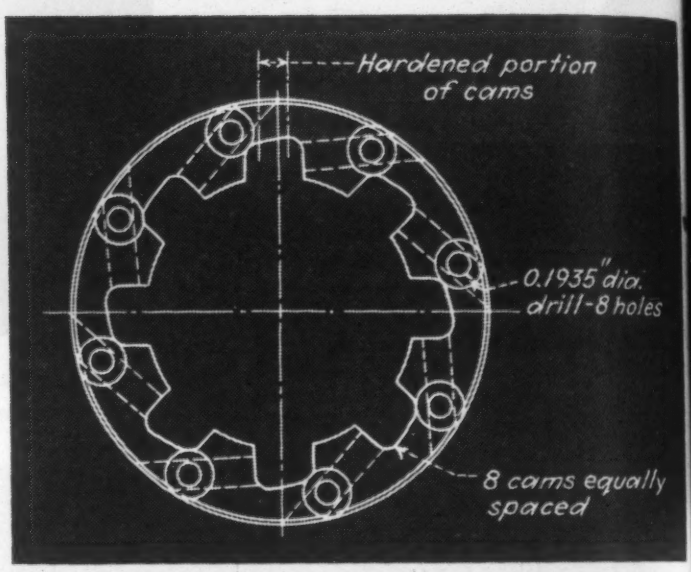
The machine consists of an arbor



Cabinet containing equipment for proportioning and feeding propane and oxygen to flame hardening machine.



A closeup showing the cam ring in position on the arbor and being heated. Above ring is a Rayotube focused on a point on the ring O.D. just above the surface being heated.



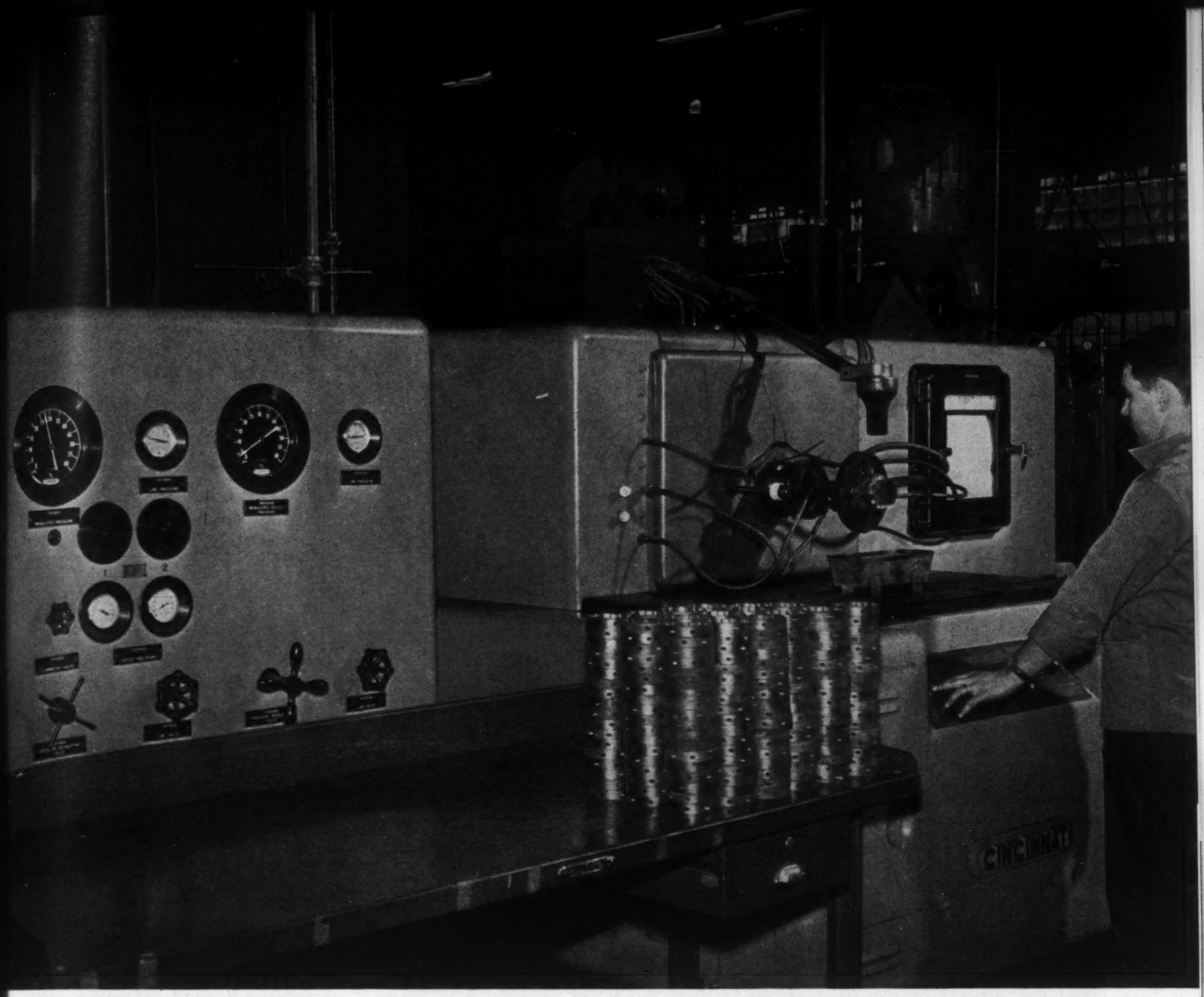
Drawing of one of three similar cam rings for the Dynaflow torque converter shows bearing surfaces that are flame hardened.

support for the work (the arbor can be rotated but remains fixed for this application), a series of gas jets that are precisely sized and located, a means for feeding gas through the jets at a controlled rate, and igniting it and shutting it off when the work is up to temperature. An ejector pushes the piece off the arbor into a quench tank and the rings fall onto a wire belt conveyor, by which they are removed from the quench and deposited in a tote box.

An important part of this machine is the sensitive electronic temperature control using a Leeds & Northrup Rayotube that includes a thermopile on which a lens focuses the radiant energy emitted by a critical area of the ring being heated. The emf generated in the thermopile is transmitted to an indicating recorder so arranged that gas flow is shut off automatically and the ring being heated is ejected into a quench tank the instant the area on which the Rayotube is focused attains the temperature for which the recorder has been set. This temperature, of course, is that which has been found to indicate that the areas to be heat treated have attained the required quenching temperature. Control of the temperature is so close that the required depth of hardness penetration is assured and, as a result, adjacent areas remain soft, as desired. Careful checks have shown that a high degree of uniformity is attained, with the result that scrap that ran up to 10% in the induction heating setup has been virtually eliminated.

Besides the electronic and electric units already mentioned, there is equipment for indicating and controlling gas flow and gas pressures. Both the pressure and the composition of the heating gas are automatically controlled, for even small variations in these changes the hardness pattern since they affect the time that elapses after ignition until the temperature set is attained. The Rayotube and recorder circuits are responsive only to radiant heat of the surface on which the tube is focused. This surface is a portion of the outer diameter of the ring directly opposite to that of the topmost cam surface being heated; as soon as this surface reaches the temperature set, gas is shut off automatically.

Ejection of the ring into the oil quench is accomplished by automatic retraction of the arbor the instant that the cam surfaces are up to heat and the gas flow is shut off. The machine includes automatic control of the temperature of the quench by pumping the oil through a water cooled heat exchanger. Speed of the quench conveyor belt is variable and is set so that the rings are discharged to a tote box at the desired temperature.



Complete view of flame hardening machine. After heating, rings drop through a chute into a quench tank. At left is unit for controlling propane and oxygen flow.

Hardening Technique

Three different styles of cam rings, two having eight surfaces and one having six surfaces to be hardened, are handled on this machine, and each style has its own arbor. Arbor changes can be made in about 15 min. Each arbor is water cooled and has a set of eight ports or tiny jet openings for each cam face, which measures about ¾ in. square. Jet holes are produced by a No. 65 drill; three or four holes are uniformly spaced in a line to heat each cam surface. The number of holes needed depends upon the width of cam face being heated. Back of the ring is a water cooled plate that helps to keep heating confined to areas in which it is wanted.

The machine is operated by one man who loads the machine and starts the cycle. One machine can harden at the rate of more than three times that previously attained with three induction heating machines. Cost reduction is appreciable even without allowing for the near elimination of scrap. And elimination of scrap is important, as the rings are expensive, partly because they have to undergo numerous machining operations before they are ready for heat treatment.

Heating time ranges from 9 to 12 sec. Loading requires 3 to 4 sec., hence the total time of the cycle is 16 sec. maximum and about four pieces a min. are heated and quenched. The operator merely loads each piece and presses the starting button. When the set temperature is attained and gas is shut off, the piece is instantly pushed off the arbor and drops into the oil quench.

Gas supply for the machine comes from outdoor tanks, one stationary tank holding 1,000 gal. of propane and two trailer units carrying 20,000 cu. ft. of oxygen each. Gas supply pressure is set at 15 psi. on the propane and 100 psi. on the oxygen; flow to jets is controlled and proportioned by regulators in a cabinet back of the regulator panel. This cabinet includes a safety flash-back chamber on the propane line. Pressure gages and manual control valves are on the front of the panel.

Adjustments are such that the gas mixture supplied to the jets contains one part propane to three of oxygen, by volume. It requires about ¼ cu. ft. of propane and ¾ cu. ft. of oxygen per ring to do the heating. The flames are slightly reducing so that little or no scale is produced.

Once the machine is set up and adjusted for the part to be heat treated, operation is fully automatic except for hand loading each ring and starting the cycle by pressing a button. Since the human element is largely eliminated, the results secured are uniform.

The exacting requirements of high temperature service demand high quality forging alloys and closely controlled forging practice.

Forging Alloys for High Temperature Service

by **L. S. FULTON,** Universal Cyclops Steel Corp.

● CONSIDERABLE INVESTIGATIVE work has been done during the past four years upon high temperature alloys for use in jet aircraft engines and gas turbines developed as prime movers. The really unbelievable temperatures and stresses to which the moving parts of these power plants are subjected require alloys having exceptionally high physical properties at elevated and room temperatures, high rupture stress values, good creep strength and damping capacity, considerable endurance, and high resistance to oxidation and corrosion. In addition, they must be capable of being hot-worked, welded, and machined without too much difficulty.

The types of forgings required for jet aircraft engines, gas turbine power plants, mobile and stationary, and powdered coal turbines for locomotives can be covered in three general classifications: (1) Alloy steel forgings that are used as shafts, gears, and other members. (2) Disks, contour forged wheels, rotor forgings, and compressor wheels that are fabricated from some special alloy to withstand the necessary stresses. (3) Blade and bucket forgings, also usually of some special alloy designed to meet the complex stresses these parts must resist in operation.

The materials in the first group follow the forging practice customary for low alloy steels. The second and third groups make use of many materials, from aluminum alloys used in the cold end of the compressor to such alloys as N-155, S-590 and S-816, used for turbine wheels, and other parts requiring high strength at high temperatures. In addition to the aluminum alloys, the alloys currently used can be divided into: (1) iron-base, (2) nickel-base, and (3) cobalt-base alloys. Compositions of some of the commonly used alloys are given in the accompanying table.

There are other alloys, including iron-base, nickel-base and cobalt-base materials, that are under development at present. However, sufficient data have not been obtained about their performance and workability to discuss them as yet. Of the cobalt-base alloys, only S-816 and vitallium have been forged successfully at the present time; the other alloys have been used primarily as precision castings.

Production of Forging Billets

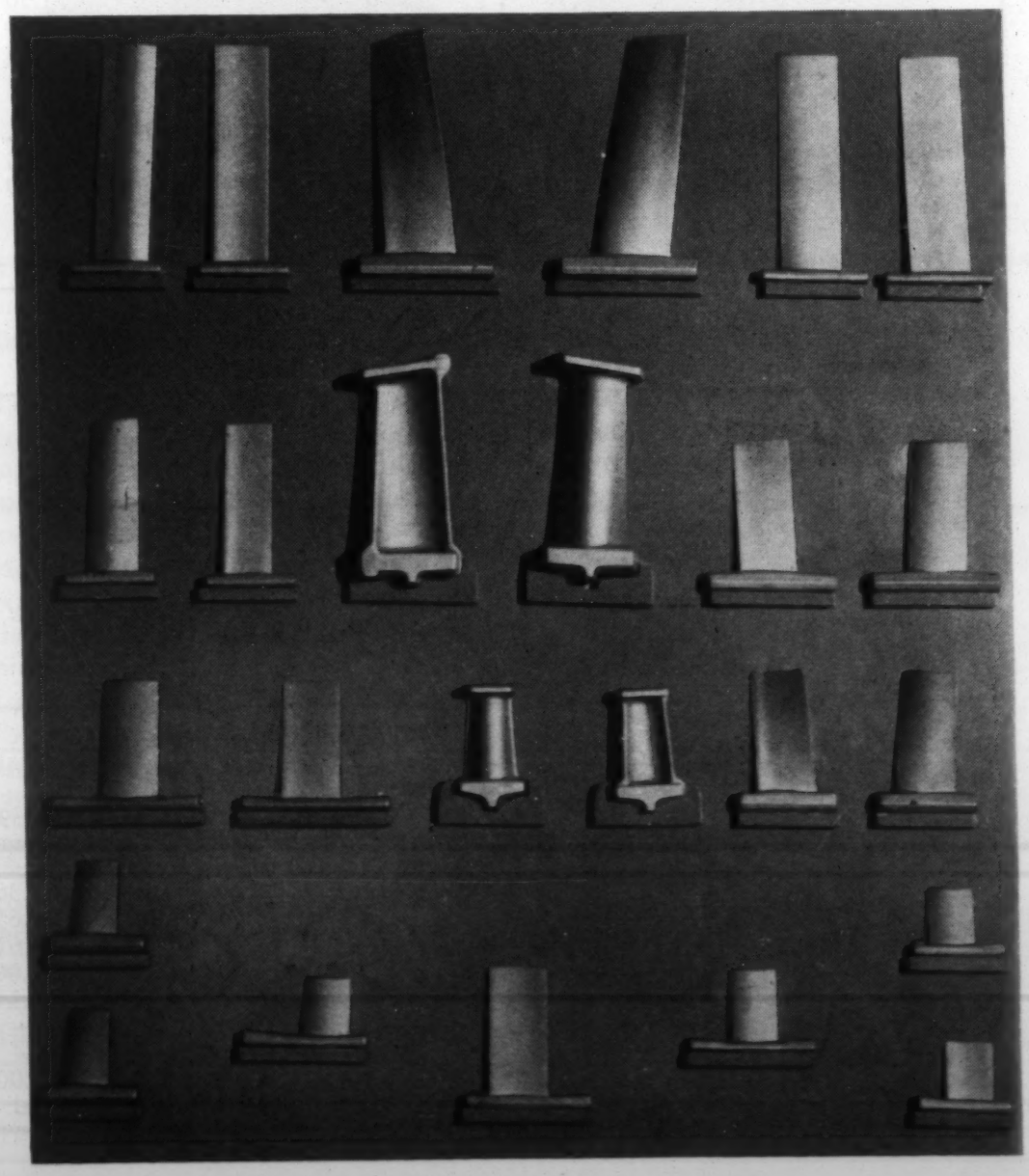
It may be well to discuss first the fabrication of billets and rough turned rounds for the forge shop's ultimate use. The writer's company is primarily interested in supplying billets and rounds for subsequent forging operations. Until recently billets for turbine wheels were required in from 3-in. rounds to 8½-in. squares. Billets of highly alloyed material are now being asked for up to 20-in. squares with good surface conditions and sound centers.

The usual practice is to melt in an ingot mold of such size that there will be a reduction of at least 3 to 1 from ingot to billet. The material is melted to a controlled grain size; for many uses No. 1 grain size or smaller is satisfactory. The ingots are either preheated or are charged into a cool furnace and heated to 1900 to 2150 F in a neutral or slightly oxidizing atmosphere. First operations under a press or hammer are very light until the metal starts to flow, when the amount of reduction can be increased, using ordinary precautions required for highly alloyed materials. The billet is press-cogged, and ground all over, and the process of working down is continued. About 95% of the material is forged on flat dies. Precautions must be taken to prevent its going to a V-shape, as the center would be ruptured in returning it to a round. Close temperature control is necessary at all times both in preheating and in heating to the required forging temperature.

When reducing to intermediate size, forging is stopped on most alloys at about 1800 F or slightly less, and the semiforged material reheated. The

Great care must be exercised in producing the high alloy billets. Here a heated billet is shown emerging from the billet heating furnace. (Courtesy: Porter-Blairsville Co.)

A typical group of forged turbine buckets (the four in center) and compressor blades. Buckets are of S-816 alloy and blades are of 403 stainless steel.



number of reheatings depends upon the original size of the ingot and the material involved. Three or four heatings are usually required with material of low alloy content, and as many as eight or more with such alloys as S-816. After reduction, all billets are given two or three grindings, and are stress relieved; smaller bars are given four or five grinding, rough turning, or centerless grinding operations to produce the finished size required.

Classes of Forging Alloys

There are two classes of material now being generally used for turbine wheels: (1) Those grades that necessitate hot cold-working to produce the required physical properties; and (2) those that require solution treatment and age hardening to meet requirements. Under these classes it will be found, however, that some engineers request that all material be hot-worked whether it be of the lower alloy content or not. To forge wheels or rotors of the material of the first class requires billets with exceptionally good surface and with no harmful center segregation. These billets after being cut into multiples are semi-blocked, blocked, and then allowed to cool for surface inspection. Any defects present are removed by grinding. The billet is again reheated to

the recommended temperature and forged to some predetermined size, allowing sufficient material to remain so that it can be hot cold-worked from 10 to 20% at a temperature of about 1250 F for most materials, 1325 F for others. The billets are then stress relieved at 1200 F for a definite period of time, usually from 4 to 16 hr., depending upon size.

It is rather difficult to give the exact amount of reduction in the various forging operations because each turbine wheel requires an entirely different forging technique to produce the properties required in the specification.

Billets in the second classification also must be free from surface defects and have sound centers. They are heated to recommended forging temperatures in a neutral or slightly oxidizing atmosphere. As these alloys are much stiffer at forging temperatures than ordinary alloy steels, they cannot be worked to any extent at low temperatures, and must be reheated as often as necessary to insure proper hot working. Close control of temperatures is a necessity to avoid danger of burning if too hot and cracking if too cold.

After forging alloys such as S-590 and N-155, it is necessary to solution treat by heating to temperatures of 2100 to 2250 F, and to cool quickly in oil, water, or air to produce best structures for the application intended. They are then aged at temperatures of 1200 to 1500 F, depending somewhat upon actual operating temperature, and air cooled.

Forging Methods and Equipment

The sizes of turbine wheels and disks involved vary considerably, and the type and size of forging hammers used to produce them usually run from 10,000-lb. to 35,000-lb. size. There have been some cases where the smaller wheels have been produced on hammers as small as 4,000 lb. To produce the wheels requiring the hot cold-working is an exceptionally difficult task, and is very hard on dies and hammer parts.

As the number of forged turbine wheels is quite small compared to the quantities of compressor blades and turbine buckets made, considerably more time has been devoted to developing die steels and forging techniques for the latter parts. Forging equipment presently consists of 1500-, 2000-, 2500- and 3000-lb. hammers, No. 5 Maxi-presses and the equivalent Ajax presses, and hot upsetting machines. It is the opinion of many that there is some advantage in the use of hammers in that improved die life is the rule. Presses are faster,

Compositions of Some High Temperature Forging Alloys

TYPICAL IRON-BASE ALLOYS								
Alloying Elements	Timken	19-9-DL	G-T-45	N-153	S-588	N-155	S-590	G-18-B
C	0.15	0.26	0.08	0.10	0.42	0.10	0.49	0.40
Mn	1.14	0.52	1.25	1.50	1.50	1.54	0.60	0.80
Si	0.84	0.57	0.50	0.50	0.80	0.44	0.21	0.90
Cr	16.75	18.95	17.30	17.00	18.38	21.44	19.50	12.80
Ni	25.62	9.05	13.80	15.00	20.31	20.40	19.78	13.26
Co	—	—	—	13.00	—	19.82	19.35	10.42
Mo	6.29	1.22	2.90	3.00	4.18	2.96	3.95	1.62
W	—	1.19	—	2.00	3.08	2.11	4.15	2.89
Cb	—	0.30	0.45	1.00	4.69	1.08	4.04	3.28
Ti	—	0.21	0.30	—	—	—	—	—
N	0.14	—	(Cu 3.10)	0.14	—	0.14	—	—
Fe	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.

TYPICAL NICKEL-BASE ALLOYS				
Alloying Elements	Hastelloy B	Hastelloy C	Refractalloy	Nimonic 80
C	0.06	0.06	0.03	0.04
Mn	0.60	0.70	0.70	0.56
Si	0.40	0.40	0.65	0.47
Cr	—	15.00	17.90	21.18
Co	—	—	20.00	—
Mo	28.00	17.00	3.03	—
W	—	5.00	—	—
Ti	—	—	2.99	2.44
Al	—	—	0.25	0.63
Fe	5.00	5.00	19.00	1.00
Ni	Bal.	Bal.	Bal.	Bal.

TYPICAL COBALT-BASE ALLOYS						
Alloying Elements	S-816	Vitallium	61	6059	422-19	X-40
C	0.36	0.30	0.42	0.40	0.40	0.48
Mn	0.40	0.35	0.28	0.30	0.30	0.64
Si	0.28	0.55	0.57	0.65	0.51	0.72
Cr	20.24	28.70	24.21	24.61	24.75	25.15
Ni	20.51	2.00	1.00	33.00	15.92	9.69
Mo	3.85	5.57	—	5.34	6.08	—
W	4.39	—	5.38	—	—	7.23
Cb	3.92	—	—	—	—	—
Fe	3.28	1.00	1.00	1.00	1.00	1.00
Co	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.

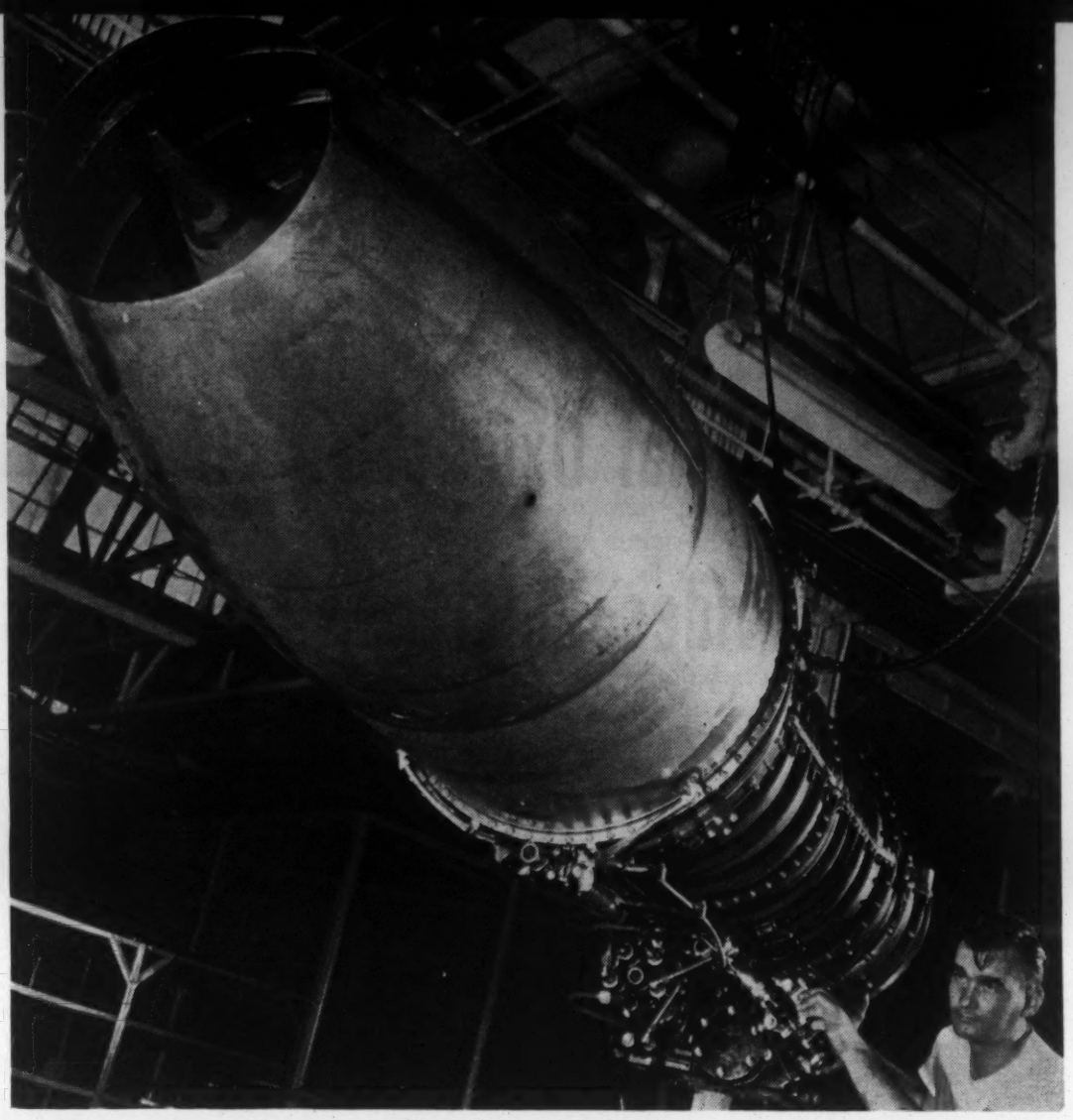
however.

Impressions in the dies are being produced by the conventional die-sinking methods, hot typing or cold hubbing. These latter two methods are not in wide use but should be used more widely when the techniques are learned and as equipment becomes available.

The material used most extensively at present for dies is the low carbon 5% chromium-molybdenum-tungsten grade, and it has had great success. The heat treatment of these dies is very important, and should insure freedom from carburization and decarburization, and keep scaling to a minimum. They are usually tempered to a hardness of Rockwell C 50 to 53, though at times they are used at a somewhat higher hardness. A double tempering is recommended, with a final bluing by reheating to a temperature just below that of the last tempering operation. Prior to placing the dies in service the surfaces should be carefully polished to remove all tool marks and scratches. Recent practice has shown that vapor blast or liquid honing methods give fine results.

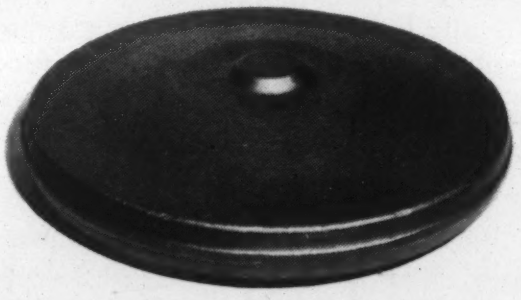
As the compressor blades and vanes are not subjected to as high operating temperatures as the turbine buckets, materials such as carbon and low alloy steels, aluminum, and SAE 403 steel are used for them. These can be precision cast or forged. At present, however, the greater quantity are formed from turbine quality SAE 403 material. The usual practice is to upset the root section to a favorable size and then to forge in the finishing impression. No exact procedure has been adopted as standard, due to the different end results. Since these materials have been forged for many years, they will not be discussed here.

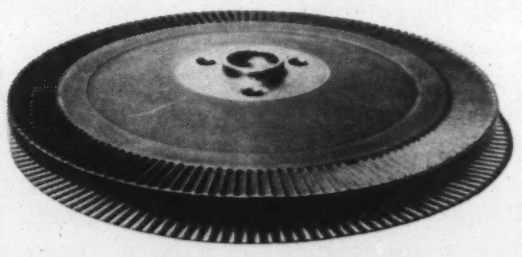
The most important and by far the most difficult forging operation is the fabrication of turbine buckets. Only the most highly alloyed materials are used for this application, and the designs for these blades, some of which are still held as confidential, are such that the actual forging requires innumerable operations. The root sections on these buckets are either upset or extruded, after which they are forged in repeated operations under small hammers. Forging heat is lost quite rapidly after two or three blows on most of the materials, and consequently, numerous reheatings are necessary as the operation progresses. The most commonly used bucket material at the present time is S-816, though such alloys as Timken, 19-9-DL, N-155, Inconel X, and Hastelloy B and C are also used. All the material supplied to the forge shops is in the centerless ground condition.



Improved forging alloys have played an important part in the advances made in jet aircraft engines.

Here shown is a typical compressor wheel for high temperature service. Left, the disk as forged; right, after machining and with blading attached.





In the upset or extruding process the material is usually heated to the proper temperature in induction heating furnaces, and the semifinished forgings are heated in controlled atmosphere furnaces to produce a surface as free from contamination as possible. It is usual practice to give the semifinished forgings an anodic pickling to detect the presence of surface defects, using phosphoric acid as the electrolyte. Any defects found are ground out and the forging is continued.

It should always be remembered that these alloys are liable to rupture in the initial forging stages, and proper precautions should be taken at this point to control the reduction necessary for subsequent forging. Close control of temperature must be maintained at all times.

After these forgings have been fabricated, treated and machined, they are subjected to various types of inspection, such as Magnaflux, Zyglo, ultrasonic, and X-ray examination. Any inherent flaws that may be detrimental to the proper functioning of the part are cause for rejection. To meet these requirements it is necessary for the forge shop to obtain material as sound as can be produced, and to use utmost care in the fabrication of this material.

Acknowledgment

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Special Oxide Film on Steel Provides Electrical Insulation

by P. L. SCHMIDT, Materials Engineering Department, Westinghouse Electric Corp.

Blue iron oxide produced on silicon steels by steam atmosphere treatment serves as an effective insulating medium in electrical machinery.

● ONE PROBLEM continually facing engineers is the selection of a proper material or process for electrically insulating, from one another, the punchings which make up the laminated iron cores of electrical machinery. Years ago a type of inexpensive varnish, known as core plate enamel, was used for this purpose; more recently, many laminations have been coated with sodium silicate. Although core plate enamel and sodium silicate provide good insulation, they have been found undesirable for certain applications such as flood control machinery or railway motors. In order to find a substitute for core plate enamel and sodium silicate for these and other applications, a development program was carried out. As a result, a method was developed for producing on electrical steel thin, tightly adherent oxide films that provide satisfactory insulation and good paint adherence while making a negligible change in space factor (the percent of space occupied by magnetic material).

Briefly, the method consists of exposing silicon steel laminations to a steam atmosphere at a temperature of about 930 F. It has been found to produce a satisfactory oxide film on all grades of electrical steel having either a high or low silicon content. In general, the low silicon grades are best suited to the process, but even the 4.5% silicon steels oxidize sufficiently for most applications.

The most important feature of the steam oxidation process is the consistency of the film produced. Red oxide, which is loose, powdery, and easily brushed off, is not formed under the conditions existing in the furnace. The blue film produced by this process is very thin, tenacious, and has a high electrical resistance.

This film is found to be a satisfactory answer to the resistance problem in applications where core plate enamel and sodium silicate cannot be used because of the severe conditions under which the completed machine must operate. As a rule, the resistance between laminations is better than that obtained with core plate enamel and sodium silicate. In part this is due to the fact that bright portions of the punchings and burrs are most effectively coated with the blue oxide film, whereas core plate enamel and sodium silicate fail to wet and adhere to these portions of the laminations.

During 1947 steam oxidation was applied to about 400,000 lb. of laminations which were used, for the most part, in flood control and transportation motors. Insulation measurements on each production charge indicated that the oxide film adequately prevented excess circulating currents between laminations.

Methods of Producing Oxide

When interlaminar insulation alone and not stress relief annealing is required, steam oxidation can be carried out in a batch type process in which the laminations are stacked on heavy plates and the plates are stacked one above the other on the hearth of the furnace. After the charge is built, an inner cover is lowered over it and the junction of the inner cover and the hearth is sealed with sand. A steam inlet pipe passes under the inner cover to the center of the charge. After the hearth is placed on the furnace car, the car is pulled into the furnace, the steam pipe is connected to the steam generator, and the door of the furnace is closed.

The oxidizing cycle consists of heating the charge to a temperature such that no part of it is below the boiling point of water, and then admitting steam. The temperature is increased until it reaches about 930 F, where it is held long enough to insure that the entire charge reaches a uniform temperature. After a short soaking period, the charge is cooled slowly to about 570 F, the steam flow is stopped, and the car is withdrawn from the furnace.

For certain purposes the magnetic material must be annealed before the oxide insulation film is formed. The annealing step is carried out separately from the oxidation step. The material is annealed at temperatures of 1335 F and higher in a reducing atmosphere to reduce any oxides originally present on the magnetic material and to avoid forming any

iron oxide at these temperatures. Then the annealed material is cooled in the reducing atmosphere to a temperature of below 1060 F, but above 750 F, and steam is admitted to produce the blue insulating oxide film.

It was found that these annealing and oxide film forming steps must be carried out under these precise conditions to secure high quality oxide insulation on the magnetic material. For example, in one case when magnetic material was annealed above the critical temperature in a slightly oxidizing atmosphere before oxidizing in steam at a lower temperature, an oxide was produced which was similar in appearance to that of high quality oxide insulation except that it had an interlaminar resistance approximately 1/100 of that obtained in the low temperature steam oxidation process.

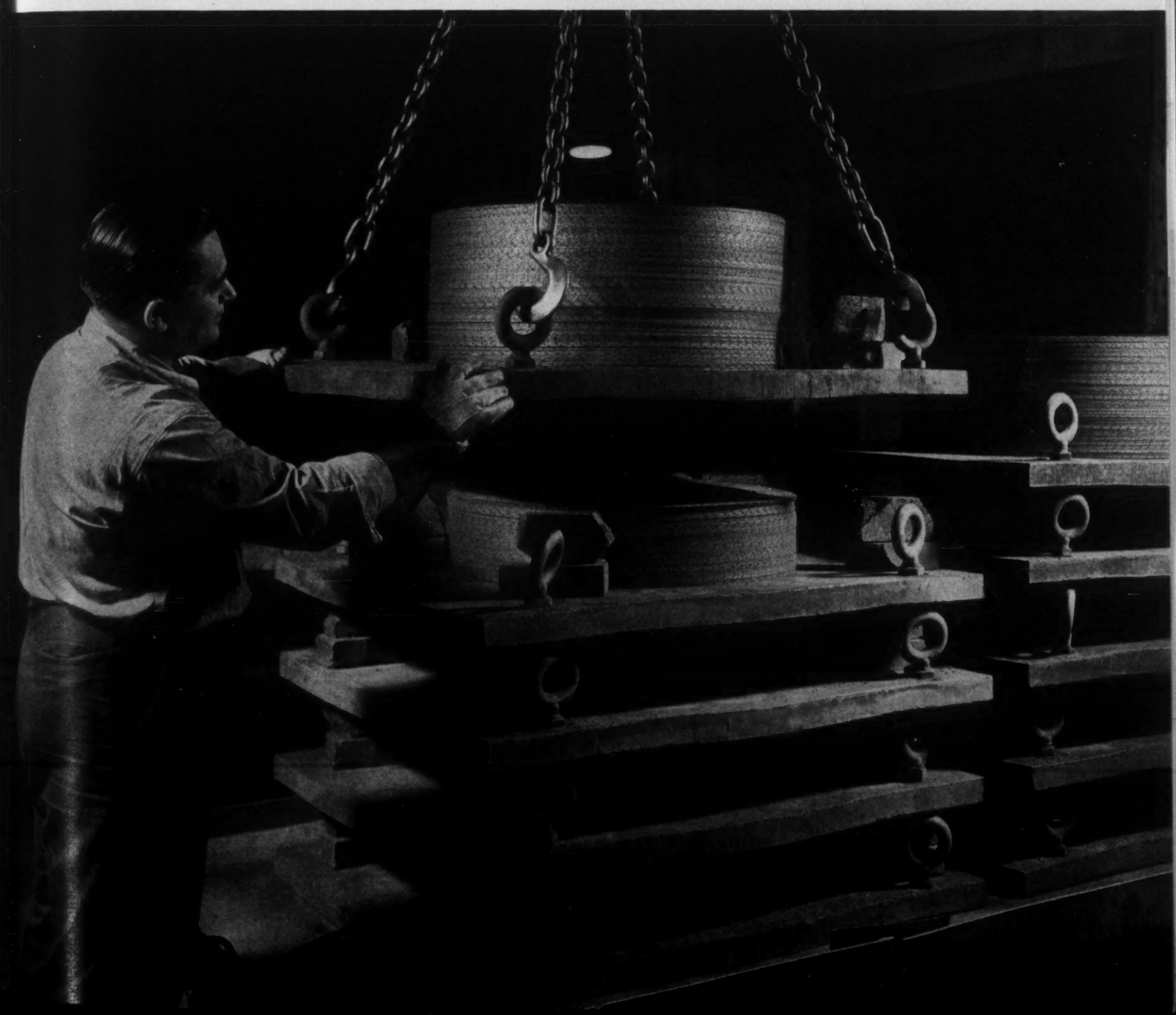
A comparative study was made by X-ray diffraction analysis of the two different oxide films. In the first attempt along this line, an X-ray diffraction pattern of the coatings was obtained by reflecting X-rays from the coating on the steel. The pattern obtained from bare steel was then subtracted from the pattern obtained from the steel and oxide film together. This method of analysis indicated that both the low and high resistance films were substantially equivalent and were predominantly black iron oxide or magnetite (Fe_3O_4).

When X-ray diffraction patterns were made of oxide powder removed from some of the low resistance laminations, it was found that iron lines in the pattern, formerly attributed to the steel in the base metal, were still present. This meant that the low resistance oxide film contained a large amount of finely divided metallic iron. This analysis was repeated for the high resistance films and it was found that very little metallic iron was present in them. Subsequently, a semi-quantitative X-ray diffraction analysis was made which showed that the high resistance oxide contained less than 15% metallic iron, while the low resistance oxide contained about 50% metallic iron. This satisfactorily accounts for the difference in electrical resistance of the two types of oxide.

It was found that under controlled oxidizing conditions above 1060 F, the predominant oxide formed is ferrous oxide (FeO). When FeO is subsequently cooled, it becomes unstable and decomposes between 1060 and 570 F into Fe_3O_4 and metallic iron. Controlled oxidation below 1060 F produces Fe_3O_4, which does not subsequently decompose.

When annealing is not required, temperatures between 750 F and 1020 F are selected as the maximum oxidizing temperature and, therefore,

Silicon steel laminations being stacked on the hearth, before placing in the furnace.



FeO is not formed. When oxidation occurs above 1060 F due to the presence of steam or oxygen in the annealing zone, FeO is formed which later decomposes into Fe_3O_4 and metallic iron. Contamination of the film by a large amount of finely divided particles of metallic iron results in poor insulation between laminations.

This explanation of the difference in composition between high resistance and low resistance oxide films has been used effectively in the design of annealing and oxidizing processes and furnaces. If it is desired to anneal and oxidize in a continuous furnace, it appears advisable to bright anneal the punchings and cool them below 1060 F in a reducing atmosphere. Then a portion of the charge advances to the oxidizing chamber through a transfer chamber, which can be quickly purged of oxidizing gases. In the case of a batch type process, a bell type furnace with an inner cover is used and the reducing atmosphere is flushed out and replaced by an oxidizing atmosphere after charge has cooled below 1060 F.

The May issue of MATERIALS & METHODS *will contain an article describing a variety of other uses for steam atmosphere treatments.*

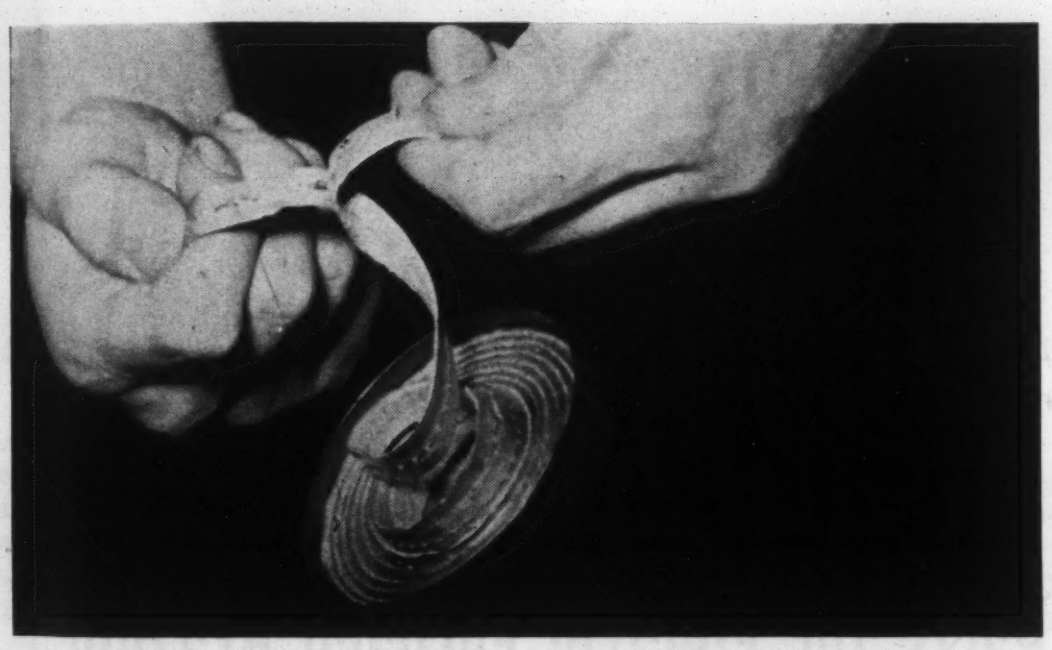
View of the inside of furnace showing the cover over the charge, the sand seal, and steam inlet lines.

New Self-Heating Tape Simplifies Soldering Operations

by ROBERT B. STANTON

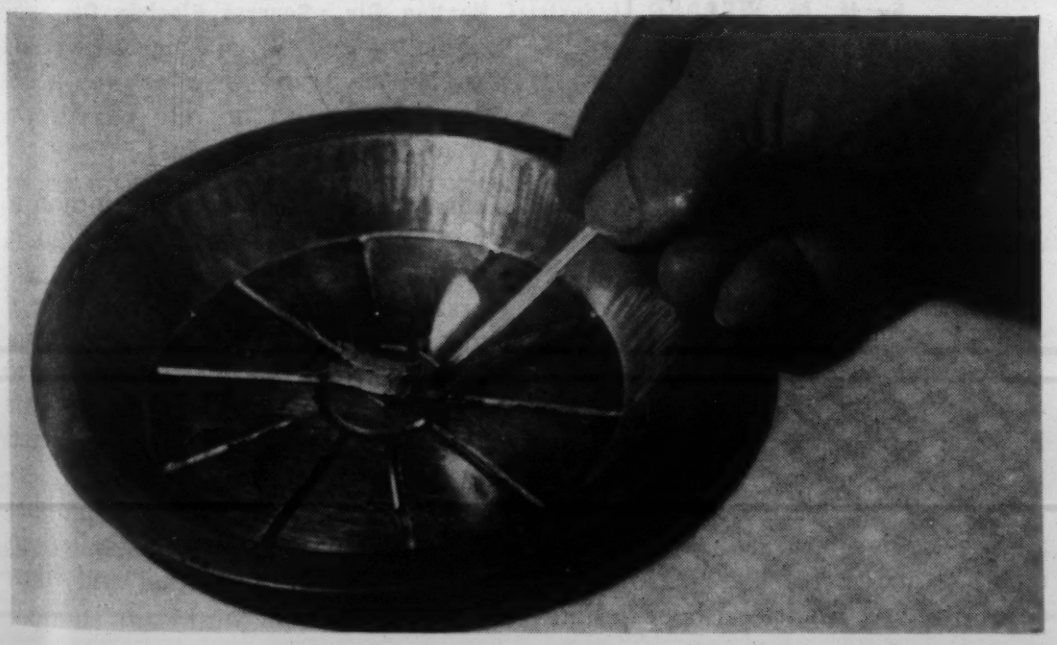
• A NEW SELF-SOLDERING tape recently developed by the W. B. Franklin Co., San Fernando, Calif., for a variety of assembly and repair operations eliminates the need for a soldering iron or torch equipment. The tape consists of a ribbon of lead-tin solder attached to a ribbon of vinyl plastic, in which aluminum-type heating fuels are dispersed. When ignited, the vinyl ribbon provides a safe and efficient heating medium for melting the solder to cause it to flow directly into the joint.

It has been used successfully to assemble copper, brass, tin, aluminum, iron, zinc, and related types of alloy wires and fabricated sheet stock with thicknesses ranging to approximately 0.201 in. There is practically no limit to the shapes of articles or parts that can be repaired or assembled with the tape if segments of the latter are pre-positioned so that the flow of molten solder will subsequently be directed into the desired joints.



Shown here are the two ribbons making up the soldering tape.

The self-soldering tape being ignited by a match to plug a small hole in a metal pan.



Following is the general sequence of operations normally required to make use of the tape:

(1) The surfaces to be soldered are cleaned with steel wool or a similar medium, and coated with a thin layer of soldering paste. (2) A strip of tape is cut to proper length for the soldering job. (3) The metallic face of the tape is positioned over and adjacent to the surfaces to be soldered, so that the plastic-fuel ribbon will be uppermost, permitting easy ignition and allowing the metal ribbon to flow into the required joint. (4) One end of the plastic-fuel ribbon is fluffed to facilitate ignition, and lighted with a match or some other flame-producing medium. (5) The ash left by the plastic-fuel ribbon is removed with a clean rag as soon as the tape ceases to burn, after which the soldered joint may be buffed with steel wool prior to inspection.

In the assembly of sheet metal parts, it has been found that especially strong joints can be produced if the metal edges are designed to overlap slightly so that the solder ribbon can be inserted between the edges and heated by the plastic-fuel ribbon through the upper sheet surface.

Spliced copper wires with 12-gage or smaller thicknesses can be readily soldered simply by pressing the metal ribbon of the tape around the spliced section from the top side so that the solder ribbon will grip the wire and maintain the overhead alignment of the plastic-fuel ribbon. Splices made from larger gages of wire should be soldered by wrapping tape segments in tight spirals around the spliced areas.

In test work, the self-soldering tape has been used at distances of less than 6 in. from inflammable fuels without starting a fire; yet the ignitability of the plastic-fuel ribbon is such that it can be lighted after complete submersion in water for several minutes, simply by drying its outer surfaces with a cloth. As it burns, the plastic-fuel ribbon gives off a clean white smoke that has no tendency to contaminate or discolor nearby surfaces.

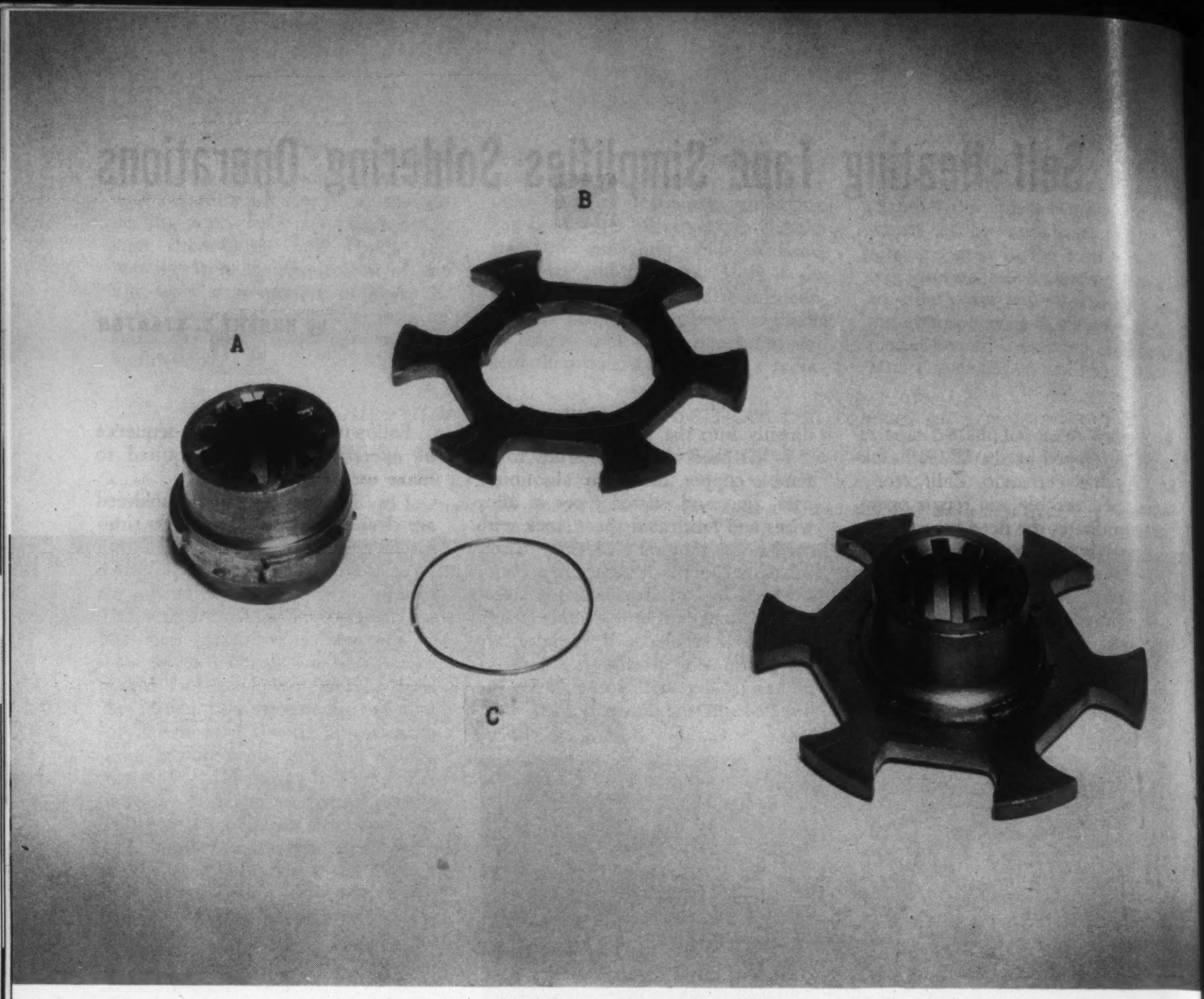


Fig. 1—An automotive clutch that was formerly forged is now a furnace-brazed assembly.

Redesigning Metal Parts for Electric Furnace Brazing

by **H. M. WEBBER**, Industrial Heating Div., General Electric Co.

Careful redesign of assemblies for furnace brazing permits combining inexpensive metal forms into low cost fabricated products of complex design.

• REDESIGNING OF metal parts is generally desirable when converting to electric furnace brazing from some other method of manufacture. Obviously, redesigning is necessary if a part machined from bar stock, or a forging or casting, is to be fabricated from multiple component parts fitted together with brazing metal preplaced at the joints. Sometimes an assembly already being fabricated by another method can be furnace-brazed with equal or better results, without design changes; but it is not uncommon to find ways to improve the design to better adapt the assembly to furnace brazing. This is particularly true if the existing fabricating method involves fixtures, because it is better to self-lock the parts together for the trip through the brazing furnace, and avoid fixtures. Several interesting examples where redesigning assemblies for furnace brazing has resulted in benefits will be explained and illustrated in this article.

From Forged to Furnace-Brazed Part

Redesign of a forged automotive clutch hub, to utilize two relatively inexpensive components which are furnace-brazed, has resulted in success at the Technical Metal Processing Co. The primary object of the change was to reduce the cost. The resultant saving amounts to about 15c per hub. The cost reduction stems from the fact that the notched flange shown in Fig. 1 at B is now made of a punching from black, hot-rolled strip steel, and the splined hub A is machined from bar stock. Thus, former machining operations on the flange have been completely eliminated and it is a little less costly to machine the hubs from bar stock than from the forging. The furnace-brazed assembly is equally as serviceable as the forging.

The furnace-brazed assembly is about 3⅞ in. in dia. by 1¼ in. high. The hub is machined from 2-in. dia. bar stock of C-1034 steel. A small outer flange is broached in three different places around the periphery to provide a keying effect when the hub is pressed into the notched hole in the punching. This is an inexpensive and effective means of increasing the torsional strength of the assembly. After broaching, three small ears are staked in its flange to provide a stop for the punching during assembly operation, and also to hold the punching in place throughout the brazing cycle. Otherwise, upon expansion during heating, the punching might slide off the hub, or at least move slightly. After the brazing operation, assemblies are hardened and drawn.

The punching is made of 0.182-in. thick, C-1035 black hot-rolled strip stock. The edges of the notched hole are used as punched, without any special reaming or broaching operations to true them up or size them. The two parts are pressed together and a copper wire ring C is placed around the hub on the top side of the joint. The assemblies are then brazed in trayloads in box-type copper-brazing furnaces at a rate of 180 per hr., and are delivered from the furnace with strong, uniform bonds and clean, bright surfaces.

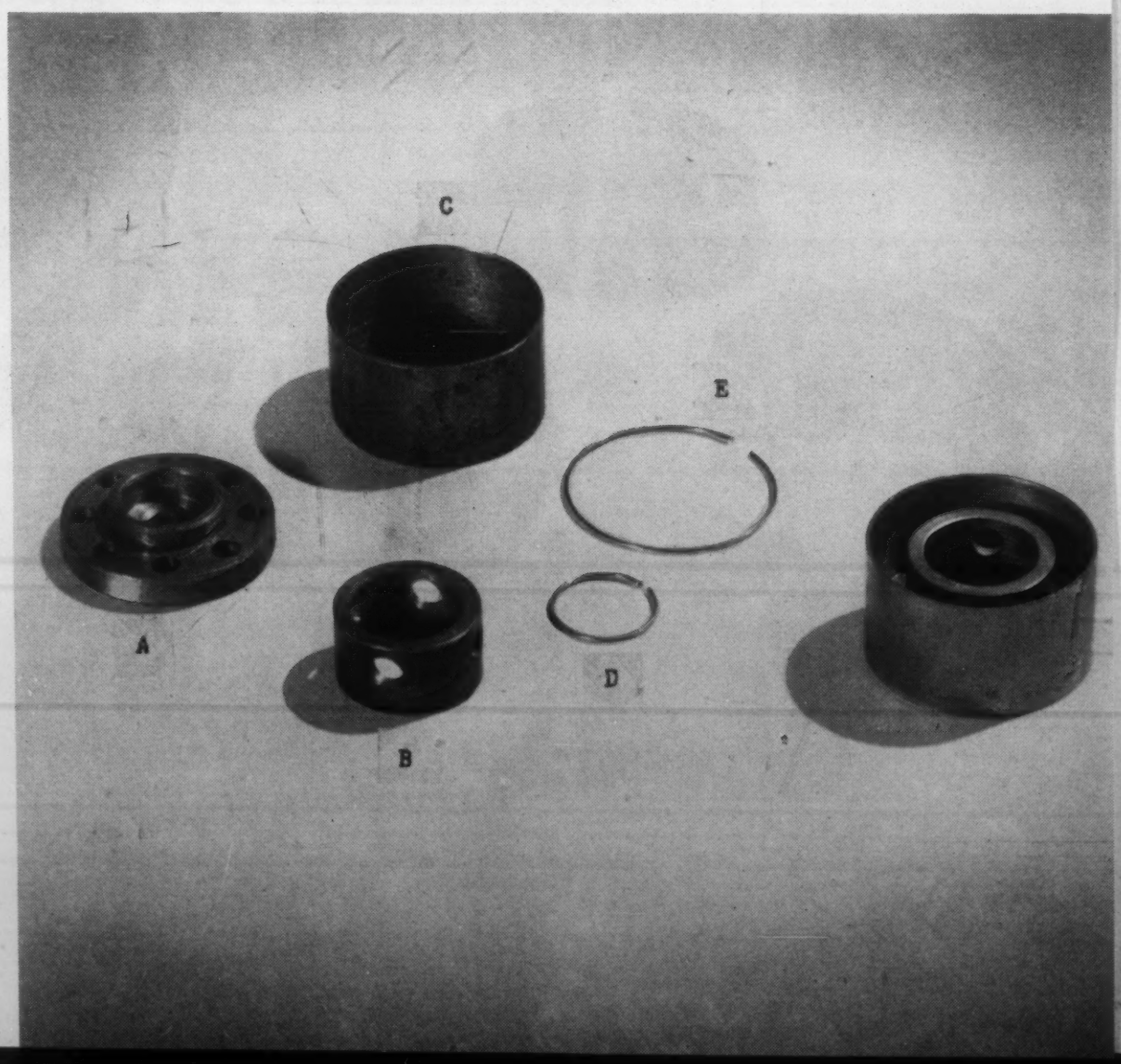
Machined vs. Brazed Assembly

There are innumerable cases where parts formerly machined from bar stock have been redesigned for fabrication from simple components to reduce the waste of metal cut away, shorten machining time, and cut costs. It is not uncommon to save 50 to 75% of the metal by such conversion, where bar stock is machined down from a large diameter to a small diameter such as to provide a small hub on a large flange, or where slugs of bar stock are bored out to produce shell-like structures. In the former case, small screw-machine parts are often brazed into large diameter punchings; in the latter case, drawn cups with suitably stamped or machined fittings, or pieces of tubing with machined or punched disks brazed into one end, often with auxiliary fittings, sometimes provide satisfactory and less expensive assemblies.

The discharge valve cage for an electric refrigeration compressor (Fig. 2), manufactured by Servel, Inc., is a typical case where redesign for furnace brazing has resulted in savings of time, material, and money. In this case, a part formerly machined from a piece of bar stock 1¼ in. in dia. by ¾ in. long, weighing 5½ oz., was bored and drilled to make a part comparable with that shown in Fig. 2 weighing 1½ oz. Now the furnace-brazed assembly illustrated is made of two pieces of tubing and a screw-machine part, originally weighing about 2 oz. before machining. Thus, the saving in weight of materials amounts to about 64%. The furnace-brazed assembly is equally as serviceable as its machined counterpart. In addition, the three component parts are all turned on high-speed automatic screw machines, which reduces the machining time.

The washer A is now machined from a piece of 1-in. dia., C-1010 bar stock and has a maximum thickness of 5/16 in. The inner ring B is machined from 13/16-in. OD, C-1010 tubing having 1/16-in. wall, and is cut to a length of 9/16 in. The outer ring C is machined on the inside from 1¼-in. OD tubing, 0.030-in. wall, to have a wall thickness of about 0.010 in. Its length is about ¾ in. The inner ring is counterbored to have a light press fit of 0.000 to 0.003 in. over the tenon machined on the washer, and these two parts are assembled in an air-hydraulic press, the ring bottoming against the washer. The outer ring is also machined to have a similar light press fit with the washer, and is pressed on in similar fashion, with the ring bottoming flush with the washer. After assembling, copper wire rings D and E are inserted into the tubular members. These copper rings have slightly larger outside diameters than the inner diameters of the tubes, and they are formed from hard, springy wire, so that they will hug the inner walls of the tubes and stay in position above the joints. Sleeve fits ⅛-in. and 3/16-in. long, respectively, provide adequate bonding area within the joints to give good strength.

Fig. 2—By redesigning this refrigerator discharge valve cage for furnace brazing, a weight saving of 64% was realized.



Furnace-Brazed Refrigerator Assembly

In the manufacture of hermetically-sealed refrigerators, every precaution must be taken to assure clean, scale-free work. The slightest amount of deposit of scale or flux within any of the components must be avoided, because if it should work loose it might clog strainers, or enter the mechanism, which would be even worse. Abrasive particles getting into the compressor would be especially serious because they might result in excessive wear and noise.

Before furnace brazing was introduced, receivers for refrigerators made at Kelvinator Div., Nash-Kelvinator Corp., were commonly torch-brazed or welded. But now electric furnace brazing is generally accepted as the ideal method for fabricating such assemblies. Redesigning is generally an important consideration, because for furnace brazing, extra care is taken to assure tightness of joints prior to brazing in order to obtain leak-free bonds after brazing. This same precaution also gives the highest strength bonds when brazing low-carbon steel with copper. Another factor in redesigning is to eliminate the use of fixtures and make provisions so that the parts will be self-locking or otherwise hold themselves in proper relationship while traveling through the brazing furnace.

With proper design and good manufacturing, the refrigerator receivers have uniformly tight, strong bonds when furnace brazed. Also, they have smooth, neat fillets at the joints. Of particular importance is the fact that they are perfectly clean and dry inside. This latter point is emphasized, because it is usually quite difficult to completely remove all oxides and flux by pickling the insides of containers; there is always the added possibility of corrosion after rinsing out because of the uncertainty as to whether they are dry. So when the refrigerator sub-assemblies come from the copper-brazing furnaces clean and dry, some manufacturing "headaches" are completely side-tracked. This advantage is not limited to the refrigeration field, however; it is equally valuable in the manufacture of an assortment of other products.

A breakdown of the component parts of the receiver assembly is shown in Fig. 3. It consists of two pieces of tubing, two stampings, five screw-machine parts, and eight copper wire rings. The main part of the assembly is a piece of 4-in. OD, 16-gage, C-1010 welded steel tubing shown at *A*. The tube and other component parts are given a caustic wash and a good rinse, after which they are ready to be assembled.

Two screw-machine parts made from B-1113 steel are assembled and copper brazed to make the receiver inlet assembly *D*, after which the brazed part is inserted into the tube *A* and swaged in place. The joint between the two parts is a light press fit, for maximum strength and tightness, while that between the assembly and tube is a loose fit, which becomes tight upon swaging. The foregoing procedure is interesting from the standpoint that a joint which has been brazed in one trip through a furnace can be put through the furnace again usually without injury to its strength or tightness.

Another sub-assembly, the valve

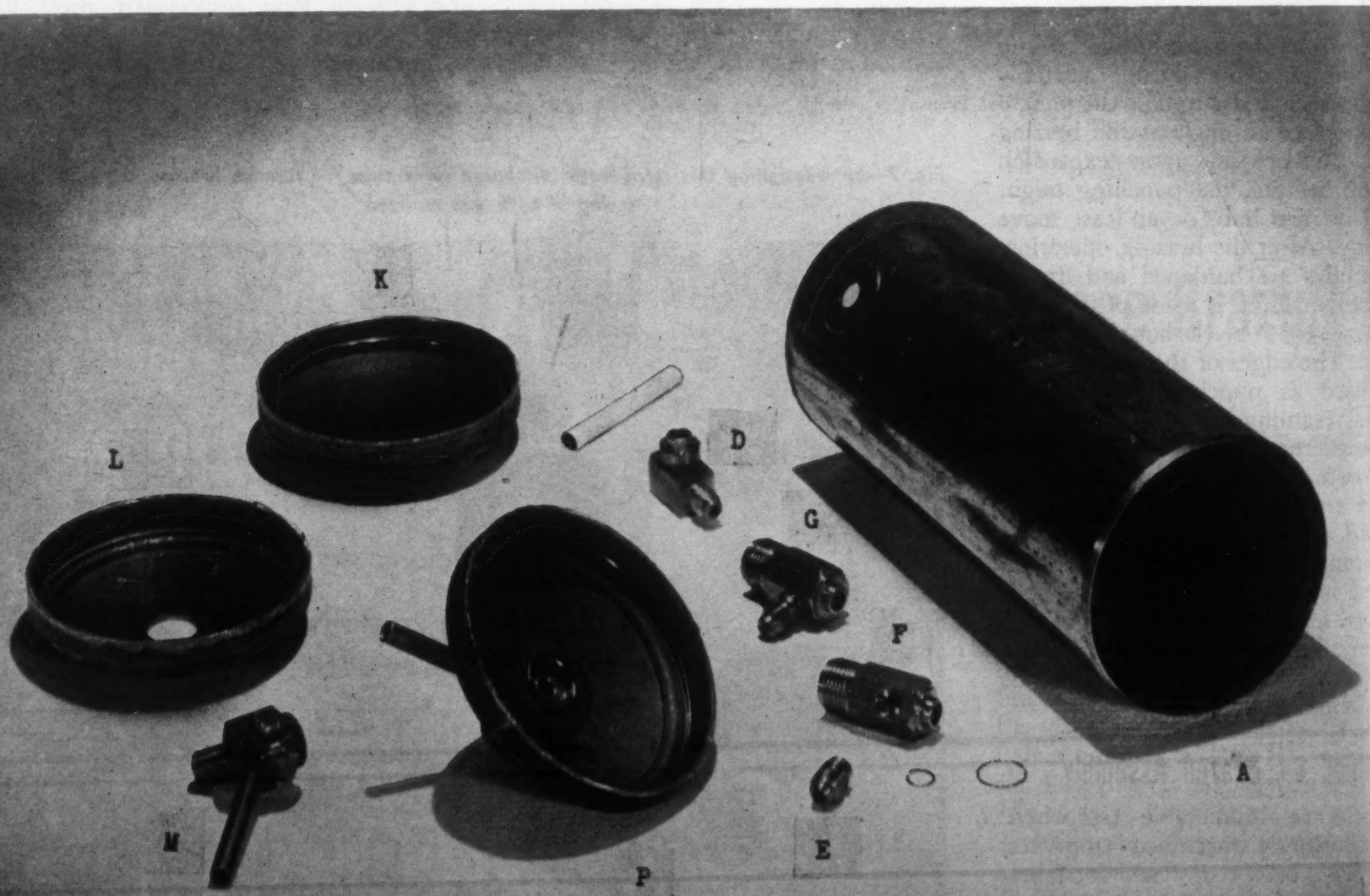


Fig. 3—Electric furnace brazing is now the accepted method of fabricating this refrigerator receiver.

body *G*, is made up of two screw-machine parts, *E* and *F* pressed together with interference fit and with copper wire rings on shoulders of the parts. *K* is a dished head made of 16-gage, C-1010 cold-rolled steel strip. Into it is pressed a 0.050-in. copper wire ring formed slightly oversize, which is pushed to the bottom of the head during assembly with tube *A*, and is locked in place by the chamfered end of the tube, so that when the brazing metal melts, it will creep throughout the entire sleeve-fitted joint. This gives a large bonding area, which aids tightness and strength.

Head *L* for the opposite end of the receiver has a punched hole in the center. A screw-machine part *M*, into which is pressed a 2-in. piece of 5/16-in. steel tubing, is inserted into the hole in head *L* and its tenon is swaged to give a tight, firmly locked joint. This feature, shown in *P*, positively assures no relative movement of the parts during the brazing cycle, and it is perhaps the best method available for joining fittings to sheet-metal parts preparatory to furnace brazing.

Following assembly of the parts with head *L*, a copper wire ring is inserted in the head and the head is pressed on end of tube *A*.

Riveted or Pinned Parts Now Furnace Brazed

Riveting or pinning has been used for years in making small sub-assemblies for business machines. However, redesigning for furnace brazing to eliminate riveting and pinning has resulted in attractive benefits, such as longer life, reduced service costs, and lower manufacturing costs. Furnace-brazed assemblies are much stronger than riveted or pinned ones; in some cases it has been possible to reduce their size and weight, which gives better space factor and less inertia, and still obtain long life. These are important advantages in business-machine design, because they sometimes make it possible to build more functions into a smaller unit.

The extreme impact and vibration to which the parts for cash registers, adding machines, calculating machines, bookkeeping machines, typewriters, postage meters, and the like are subjected, ultimately worked loose riveted or pinned assemblies in many cases. It has been found that by proper redesigning and furnace brazing such assemblies, the new parts last as long as the machines.

That the manufacturing cost is also much less can be understood from a study of Fig. 4, which compares the construction of a pinned cam cluster with a furnace-brazed one. The part is produced by the National Cash Register Co. The pinned cam cluster at the left required that the assembly be set up in a jig, and then three small holes drilled and reamed on a taper and countersunk at both ends. Tapered dowel pins were then driven into the holes, cut off to proper length, riveted at the ends, and ground smooth. This work required carefully made fixtures, involved maintenance and replacement of small drills and reamers, and took considerable time by skilled operators.

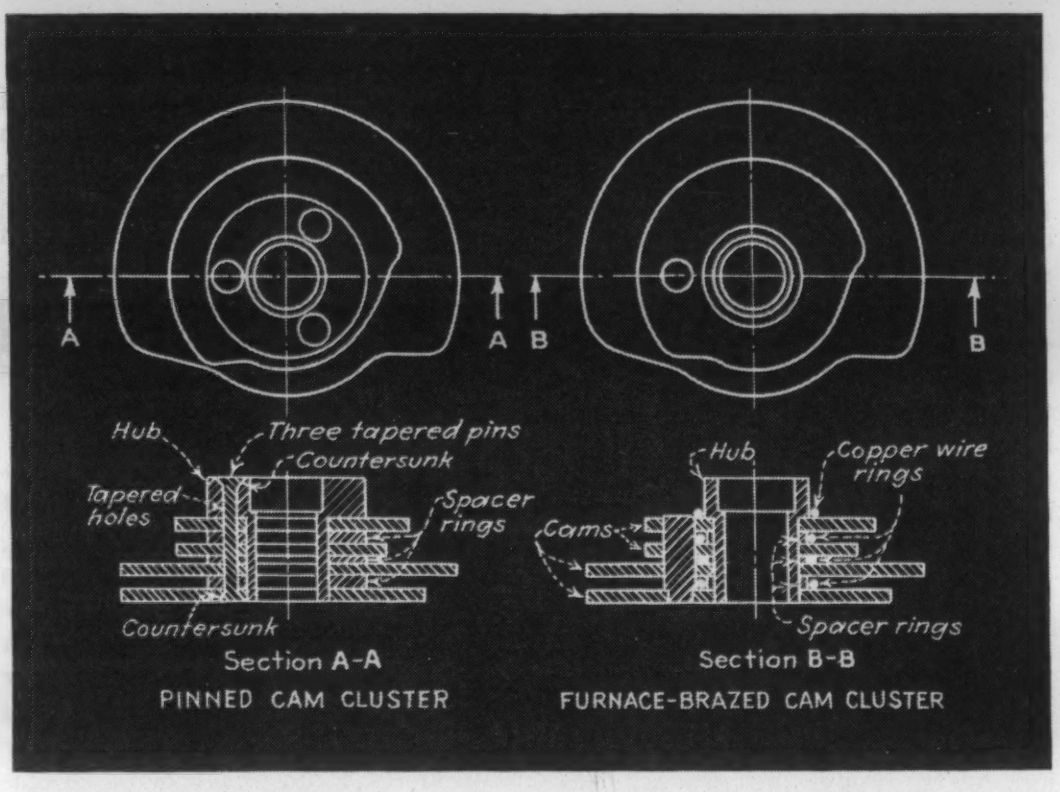


Fig. 4—The essential differences between the design of the cam cluster using pins and the redesigned furnace-brazed assembly are shown in these sketches.

The furnace-brazed cam cluster at the right eliminates most of these costly operations, and uses less material. In this case only one large straight pin is used for indexing and the other two pins, formerly tapered, have been done away with. But the indexing pin is exceptional. Usually a simple riveting over of the end of the hub holds the cams in location until they are brazed. Small copper wire rings are preplaced at the joints around the C-1112 steel spacer rings, around the B-1113 hub, and between the C-1010 cams. When the copper rings melt, they bond the assembly into one integral mass. It will be observed that the spacer rings are of smaller outside diameter than before, and the hub is machined from smaller diameter stock, which saves material and machining time.

In a set of tests on 13 typical cash-register assemblies, formerly riveted or pinned but now electric furnace-brazed with copper, it was found that the strength had been increased 52 to 287% by redesigning for furnace brazing. This improvement is representative, and explains why the parts have so much longer life. Cost savings effected by use of electric furnace brazing run in general from 30 to 90% of the costs of drilled and pinned cash-register assemblies. Actual savings vary from 40c to $10 per hundred pieces.

Many of the furnace-brazed cam clusters are carburized and hardened. In about a third of the cases, carburizing is done before copper brazing, in another third, after brazing, and the remainder require no heat treatment. The carburized assemblies are brazed in a furnace provided with a non-decarburizing atmosphere, while the other work is brazed in ordinary low-ratio combusted gas.

Newly Designed Assemblies

When a manufacturer is set up to do furnace brazing work, he frequently finds opportunities to design new parts to employ the process which he would otherwise make some other way at higher cost or having disadvantages.

An interesting example of a new assembly which is being furnace brazed under such circumstances, and one which would be extremely difficult to make any other way than by

furnace brazing, is that shown in Fig. 5. Differing from the assemblies previously described, this one is made of 18:8 stainless steel. Although the photograph gives a good idea of the outside appearance of the brazed assembly, it does not show the interior, which is honeycombed with machined ducts and radial holes. The ducts are covered with annular rings in which tiny holes are drilled prior to assembling. These rings must be bonded to the body of the assembly, tightly and strongly, keeping the interiors of the ducts completely free from any particles of oxides or flux which, if loosened, might clog the tiny holes. With so many joints to be brazed in one assembly and with this requirement for cleanliness, furnace brazing obviously is the right way to do the job. Accordingly, the product was developed to be made by this method, and results have been quite successful.

The assembly is brazed in two trips through the furnace. First, two fittings and one annular ring are brazed into the top side (left). Then the assembly is turned over and the five annular rings on the back side (right) are brazed over the ducts. Copper wire rings supply brazing metal to all the joints. Here again is a case where bonds made in a first trip through a copper brazing furnace are not impaired in the second trip through.

Ordinarily, the furnace brazing of stainless steel requires flux to obtain wetting of the copper on the steel, because of the tendency for formation of green chromium oxides even in ordinary protective atmospheres. It is practical to furnace braze stainless steel with flux to combat the oxides in ordinary protective atmospheres, and there are a few applications being performed in that manner in order to obtain certain advantages such as brazing a number of joints at one time, uniform heating, etc. However, the work coming from the furnace does carry the green chromium oxide and flux deposits, which usually have to be removed after brazing. To furnace braze without flux requires precautions previously considered more practical for laboratory work than for production. However, the technique has now been worked out to where several batch-type production furnaces are employed to bright-braze stainless steel without flux.

The technique involves enclosing the work in a sheet-metal retort and feeding pure, dry hydrogen or dissociated ammonia into the retort by means of tubes connected to a suitable gas supply outside the furnace. In this way, the ordinary furnace atmosphere surrounding the retort, which always contains too much water vapor for this type of work, does not have an opportunity to contaminate the pure atmosphere within the retort. The stainless-steel assemblies are prepared in the usual manner with copper at the joints, and the joints can either be light press fits or in some cases slightly loose, such as with 0.001-in. gap. After heating and cooling the work, the retort is opened and the work is removed. The same procedure is equally suitable for bright annealing stainless steels, or bright hardening the air-hardening types of stainless steels.

The foregoing examples are only a few of many instances where redesigning for furnace brazing has brought tangible benefits. There are innumerable cases where ingenuity has been shown in combining inexpensive stampings, screw-machine parts, and tubing into low-cost fabricated assemblies. These assemblies, when furnace brazed, show marked savings and, at the same time, usually have distinct advantages from the standpoint of both manufacturing and service performance. Although low cost is frequently the most attractive benefit from furnace brazing, often there are other advantages such as longer life, reduced weight, faster manufacturing cycle, and better appearance.

Fig. 5—The interior of this 18:8 stainless steel assembly, now furnace-brazed, is honeycombed with machined ducts and radial holes.

New Thermal Insulating Material Combines Light Weight and High Strength

— NEW MATERIALS PREVIEW

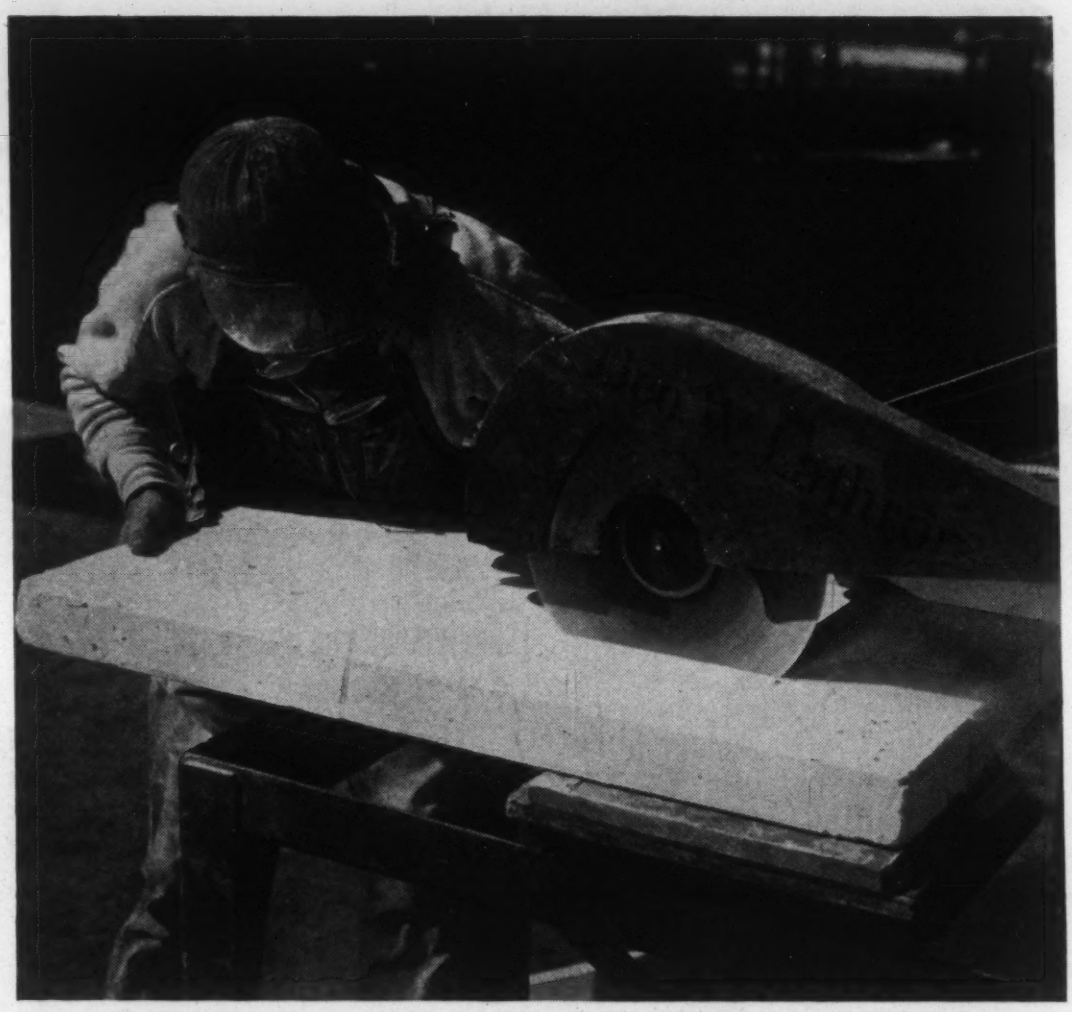
• WHEN ENGINEERING REQUIREMENTS dictate high thermal insulating properties along with fireproofness, light weight and structural strength, a new material now being offered by American Structural Products Co., an Owens-Illinois subsidiary, deserves consideration. It is a hydrous calcium silicate material sold in various forms and sizes under the brand name of Kaylo. It is manufactured in two densities—11 lb. per cu. ft. and 20 lb. per cu. ft. The lighter material is used principally for high temperature insulation. The heavier material is used for building purposes, as a tile to form structural roof decks. The 20-lb. material is also used as a core for fireproof doors, fabricated and marketed by U. S. Plywood Corp.

As a rigid heat insulation, the low-density block is suitable for use at service temperatures up to 1200 F. While not intended as a load-carrying member of any structural unit, the insulating block is reasonably strong. Following are some of its properties:

Density: about 11 lb. per cu. ft.
K factor, at 300 F mean: 0.475
Maximum service temp.: 1200 F
Standard sizes: Widths, 6 in. and 12 in.; length, 36 in. only; thicknesses, 1 in., 1½ in., 2 in., 2½ in., and 3 in.

The lighter weight is now available only as blocks in the above range of sizes, as lagging, and in some sectional pipe covering forms. Pipe covering is still in the developmental stage.

The more dense material is intended primarily for building construction. It is finding use as a fireproof roof tile, 2⅝ by 18 by 36 in. in size, where its effective resistance to passage of heat helps to conserve fuel in winter and to keep the building cooler in summer, and its light weight reduces design loads. For this purpose it is supplied with a reinforcing of steel wire mesh to give increased strength and stiffness. The wire is embedded in the block as a wire basket, providing reinforcing in both directions. Its dimensional stability is another important consideration in building construction.



The insulating material can be easily cut with hand or power tools.

Some of its properties, and the available sizes, are as follows:

Density: about 20 lb. per cu. ft.
K factor, at 70 F mean: 0.65
Standard sizes: Widths, 12 in. and 18 in.; lengths, 18 in. and 36 in.; thicknesses, 1¼ in., 1¾ in., and 2⅝ in.

Use of a block of the 20-lb. density insulation, faced on both sides with plywood, and with the edges covered with matching plywood, will create a flush door that can be finished to correspond with fine interiors, will be massive in appearance yet light in weight, and will effectively resist fire. A door of this type has already passed the Fire Underwriters Laboratory tests for a "one-hour door," indicating that it will withstand flames for one hour without being consumed and without permitting spread of the flames through the door. Use of such doors in hotels has been suggested.

While the use of the new material in the building field is an obvious choice, the manufacturing industries will also be interested in the possibilities of a lightweight, fire-resistant insulation. The 11-lb. block has been taken up as a heat insulation for high-temperature service by industry, and the heavier material may be expected to fit into industrial production when its properties become more widely known.

Liquid Blasting Cleans and Finishes Metallic and Nonmetallic Surfaces

Surface blasting with a high velocity stream of abrasive particles suspended in liquid provides an economical means of deburring, descaling and preparing surfaces for finishes.

by B. H. MARKS, Manager Hydro-Finish Div., Pangborn Corp.

● LIQUID IMPACT BLASTING provides a versatile method for use on metallic and nonmetallic materials that combines both a cleaning and finishing action. Among its many uses are deburring and removal of heat treat scale, preparation of surfaces for electroplating and other coatings, improving die and mold surface finish, and removing or blending grinding lines on machine parts and cutting tools.

The process involves blasting the surface with a high velocity stream of abrasive particles suspended in a liquid. The suspension is delivered to a blasting nozzle by means of a circulating pump. As it flows through the blasting nozzle, its speed is greatly increased by the injection of compressed air, normally 90 psi. Because the abrasive particles are suspended in a liquid, there is no limit to the fineness of the particle which can be used.

The liquid in most general use is water plus corrosion inhibitors which prevent or retard corrosion. Any type of nonmetallic commercial abrasive, as coarse as 60 mesh and as fine as 5000 mesh equivalent, can be used satisfactorily. With the finer meshes there is no breakdown of sharp edges or corners, and with extremely fine mesh abrasives it is possible to process precision machined parts and hold within tolerances of 0.0001 in. where required. A well qualified abrasive is almost pure silicon dioxide, known as Novicite, and marketed under the trade name of Pangbornite. In some cases soft grit abrasives such as pecan husks have been used for deburring plastic articles.

Equipment and Process Characteristics

The equipment used for liquid blast cleaning includes a water tight cabinet provided with a hopper tank for mixing, storing and recollecting the suspension, a circulating pump, and a blasting gun equipped with two lengths of flexible hose, one for abrasive feed and one for air supply. The cabinet has vision windows, loading doors, air control valves, and a ventilating system to remove the fog created by the blasting. The operator works from the outside of the cabinet and places his arms through gauntlet-covered armholes. The work to be finished is held in one hand or rested on a work table while the other hand directs the blasting stream.

After liquid blast cleaning the parts are usually dipped into a rinse tank containing clear water plus corrosion inhibitor. Where rapid drying of parts is desired, the solution should be kept warm (140 F). A good alternate system is to use compressed air to blow off excess water after rinsing. After parts are dry, a light protective oil is good for retarding corrosion for long periods of time.

Liquid blast cleaning is a flexible process because there are a number of factors that can be varied to meet a particular set of job requirements. These factors are: (1) particle size and hardness of the abrasive used; (2) air pressure; (3) distance from gun to work; and (4) liquid to abrasive ratio.

The process is considered economical. The abrasives, even in the finer ranges, are relatively inexpensive and have a useful life of 25 to 40 operating hours. Also, life of pump and nozzle parts is relatively long since the flow of abrasive suspended in liquid has little tendency to erode metal.

Liquid impact blasting has some peening effect which tends to improve mechanical properties and fatigue life of certain parts. This effect can be demonstrated by blasting a thin gage test strip on one side for several minutes with 80- or 100-mesh abrasive. The strip will show a definite curvature, thus indicating a peening action. Where warping is undesirable on thin gage materials, it can be avoided by using finer mesh abrasives and keeping the gun-to-work distance as great as possible.

Applications

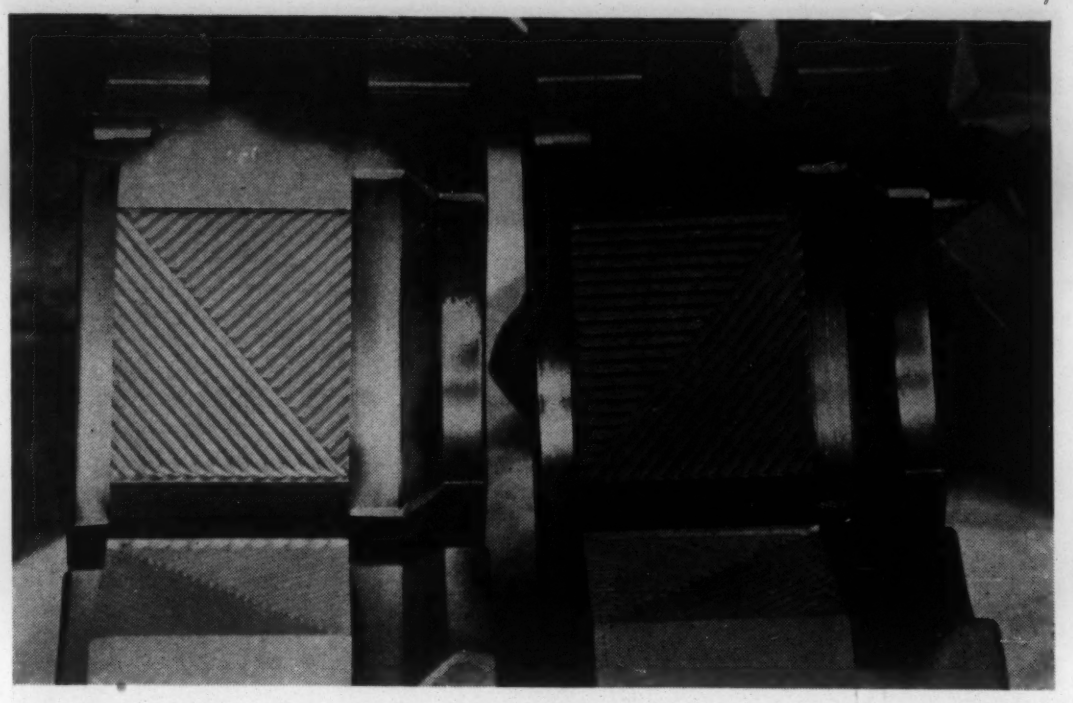
Deburring and Descaling—Liquid impact blasting offers a method for removing small burrs from accurately machined parts where hand deburring is slow and tedious. The process also removes burrs from internal pas-

sages and from very small diameter holes where the ordinary dry processes will not carry.

Many hours are spent each day by tool and die shop machinists in removing heat treat scale from plastic molding dies and in polishing these dies. A fairly simple small cavity may require as long as 6 or 8 man-hours to polish. Liquid blasting can accomplish this same job in 3 or 4 min. After the scale is removed, only a light polishing operation is necessary to restore luster. In cases where the plastic is to be used for structural purposes (inside of electrical switches, etc.) it is not necessary to use any hand polishing operations.

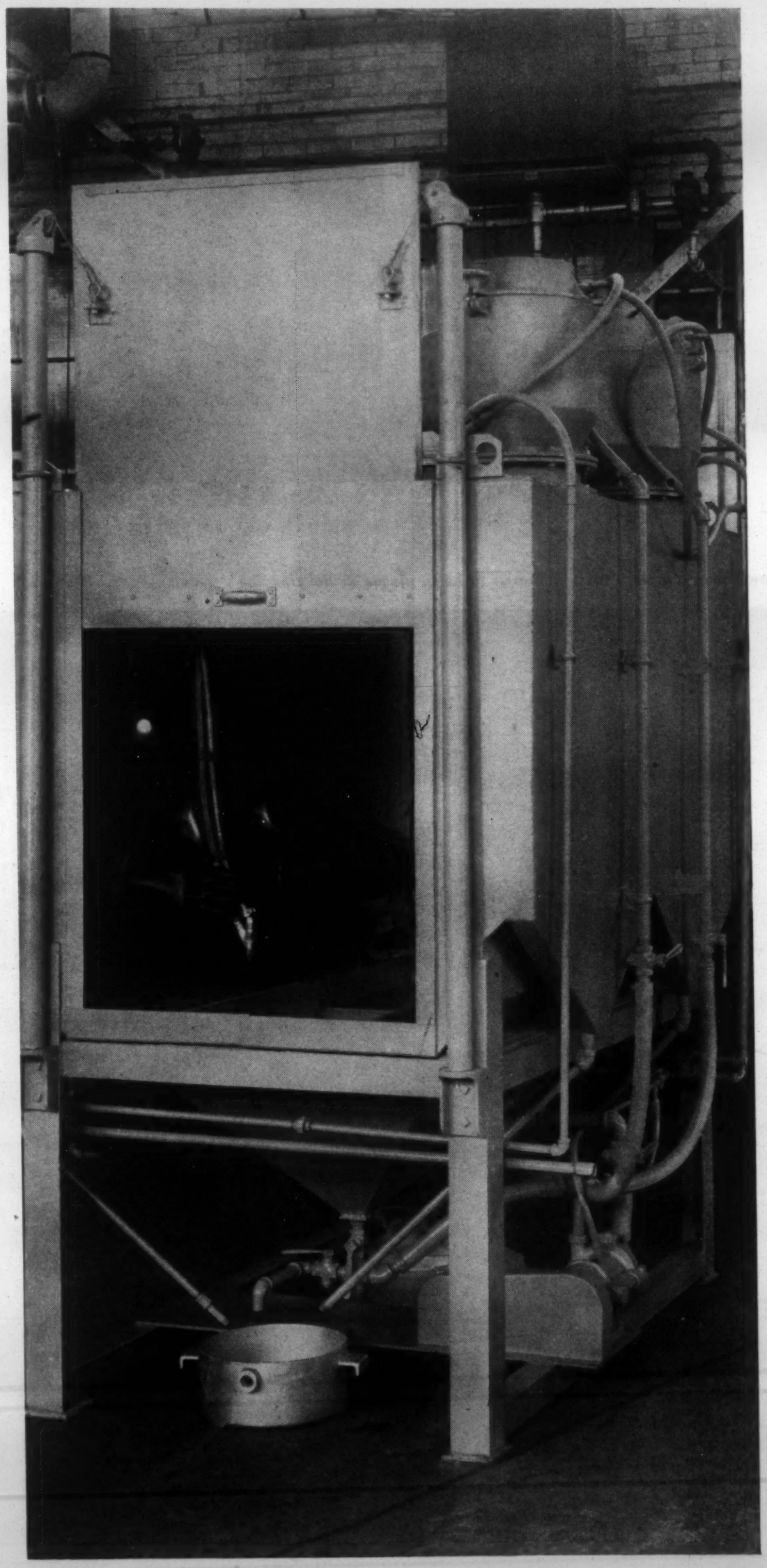
Preparation of Surfaces for Plating or Coating—Chromium plating, which is applied to tool and die surfaces or machine parts for improving wear characteristics, will be referred

Molds for glass industry are economically cleaned by liquid impact blasting. Here shown is a pressed glass mold before (right) and after (left) being cleaned by this method.



A part to be processed is shown here on a work table just prior to being placed in the cleaning cabinet.

A view of the inside of a liquid blasting unit. The operator works from the outside and places arms through gauntlet-covered armholes.



to here as structural chromium plating.

In many cases structural chromium plating is greatly improved by liquid blast cleaning the surface of the part to be plated before the chromium is applied. This finishing produces an increased amount of surface to which the chromium can adhere and, at the same time, produces a "tooth" for better bonding. It also shears all feather edges left by grinding or polishing. In many cases if plating is applied without first liquid blasting the part, the chromium will adhere to these feather edges. Under operating conditions the feather edges tend to shear and leave the plate unattached in that area; peeling of the plating then results, or is likely to result. Liquid blasting after plating produces oil storage wells which makes lubricating of this surface more easily controlled. In cases where chromium plating of die parts has heretofore been unsatisfactory, the addition of a liquid blasting operation before plating has shown a definite improvement in the adherence of the chromium. Decorative plating having a two-toned effect may be applied by means of stencils or masking tape.

Liquid blasting also has been used for improving bonding of rubber, paint, plastic and other coatings to metal surfaces. Blasting improves bonding in these cases in much the same way as mentioned previously.

Die and Mold Manufacture and Maintenance—Heat treat scale removal from plastic molding dies was discussed earlier. Liquid blasting has also been used successfully for removing the wire edge left around engraved letters on these dies. In dies used for making electrical switch parts and in many other cases this lettering is quite small and difficult to polish. Liquid blasting is a satisfactory method of polishing these letters without distorting them. Liquid blasting also offers an excellent method of removing grinding lines from intricate sections of the die. Some types of plastic dies require periodic cleaning, and liquid blasting plays an important part in finishing this work.

Liquid blast cleaning also can be used on die casting dies. New dies can be treated in much the same way as the plastic dies mentioned above. However, it is not necessary to polish the satin finish left by blasting. This finish is most satisfactory for die casting. Die casting dies require periodic maintenance due to the for-

mation of carbon deposits on the die parts.

Rubber mold manufacture and maintenance present many of the same problems described above. In this case the type and roughness of the carbon deposits left on the mold depend largely on the type of rubber stock processed. Liquid blasting has increased production life of molds which have been liquid blasted as compared with those which have been chemically treated and then hand cleaned. Liquid blasting will naturally not remove heavy uncarbonized rubber deposits left in a mold. These can be easily removed by hand. The liquid blast will then rapidly remove carbon deposits without changing mold dimensions or contours.

Mold cleaning in the glass industry has long been a costly headache. Cleaning deposits from molds by hand is a difficult, tedious job. Chuck cleaning or sand blasting can be used in some cases, but in each case metal removal is excessive and mold life relatively short. Liquid blast cleaning offers an economical, practical solution for this problem.

In forge shops liquid blasting equipment can be used to remove, blend and smooth the grinding lines on the die surface and provide for a smoother flow of metal. The use of liquid blasting for forming and deep drawing dies has also been successful. By removing the grinding lines, as mentioned before, the tendency for the die to gall and score is greatly reduced and the drawn metal shows less drawing marks. Liquid blasting the die surface also causes a better distribution of drawing compound.

Other types of dies that are frequently processed by this method are heading die and punches, extrusion dies, swaging dies, and many other types of special dies.

Other Uses—Liquid blast cleaning is useful for producing a decorative finish, and in many cases can be substituted for more costly buffing operations. This finish has been used on calibrated dial and veneers to prevent glare and increase readability of calibrations.

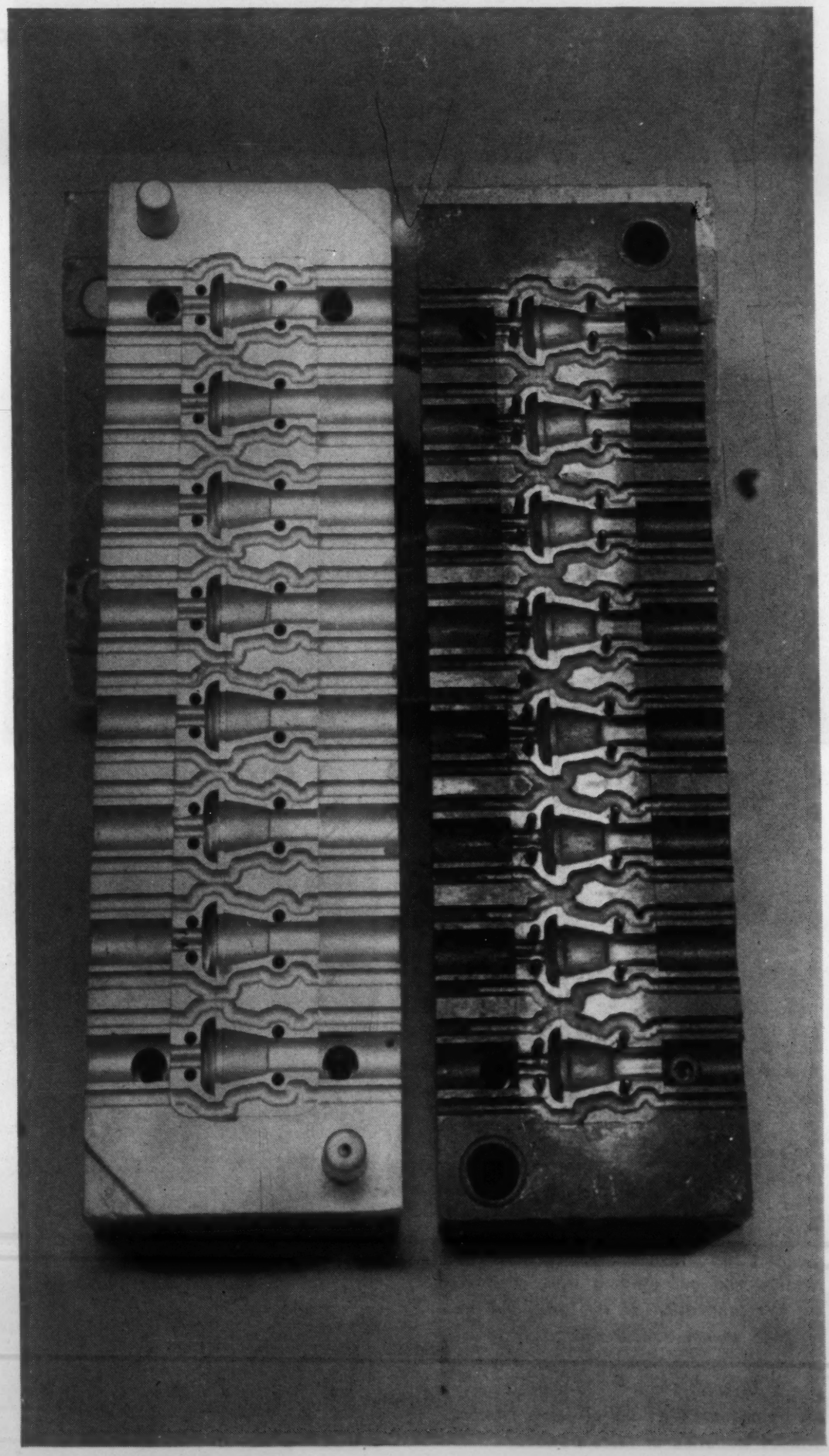
The process has also proved helpful in improving cutting tool life by removing grinding lines and feather edges from the cutting faces of the tool. At the same time it produces a satin finished tool.

Due to the highly stressed nature of many machine parts, the presence of directional grinding lines provides a source for fatigue failures. Liquid blasting can in many cases remove all traces of these lines, and in other cases blend them in such a manner as to reduce the possibility of fatigue failure.

Liquid blasting can be used to advantage for finishing threads where a smooth, close fit and easy turning is required. The process also has many possibilities for use in improving lubrication. The impact of the abrasive produces tiny indentations which serve as minute oil storage wells.

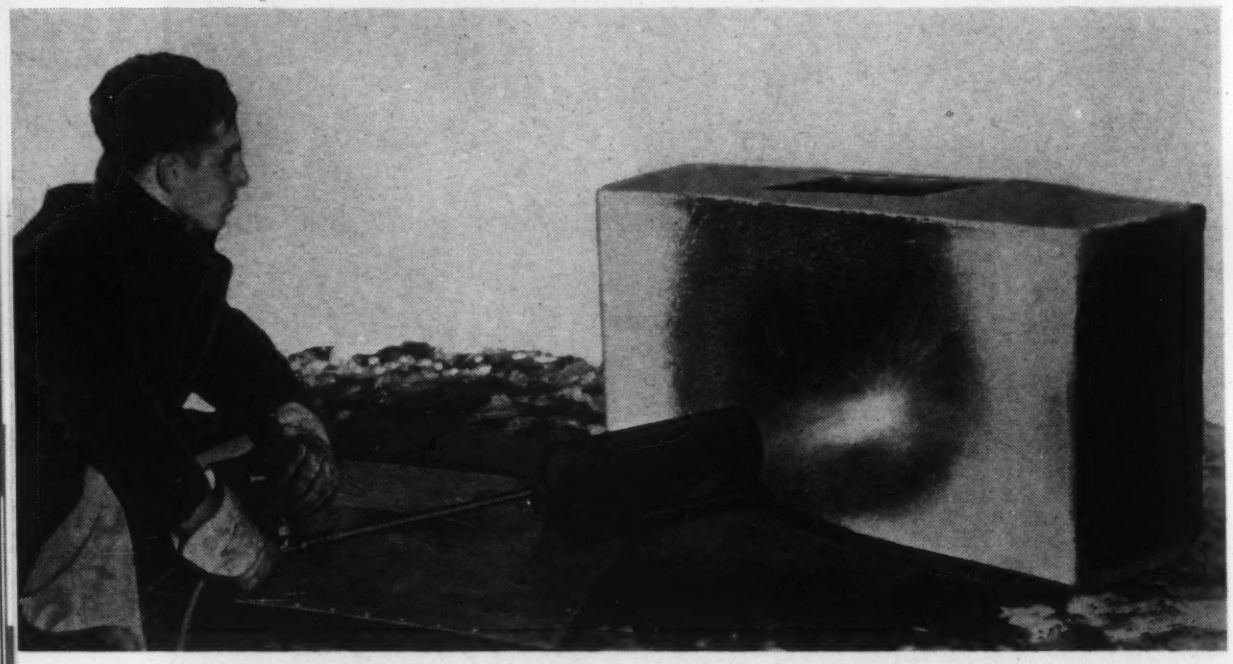
Finally, liquid blasting has a wide variety of maintenance cleaning applications. It has been used for engine overhaul work, for cleaning ordinance items, and for cleaning steam turbine blades.

One of the important uses of liquid blasting is for die manufacturer and maintenance. Right, a precision rubber mold before blasting; left, after cleaning by liquid blasting.



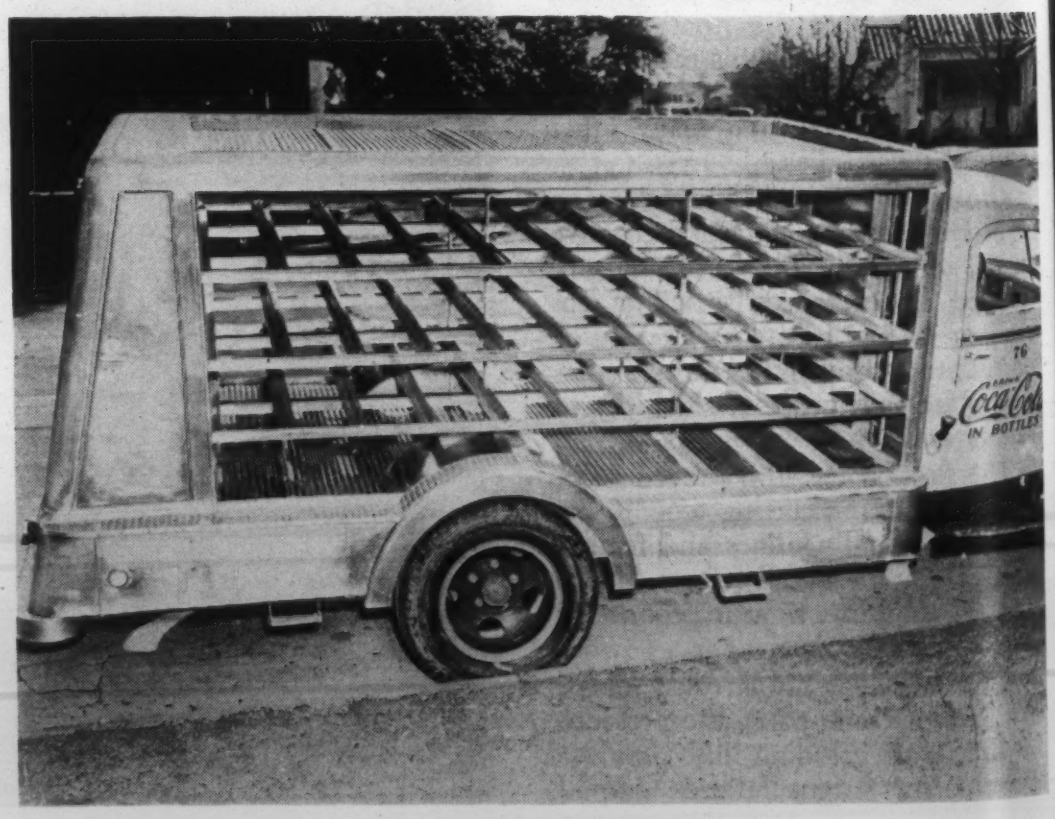
Materials at Work

Here is materials engineering in action . . .
New materials in their intended uses . . .
Older, basic materials in new applications . . .



RUBBER-COATED OIL TANK

Developed for the United States Navy by the B. F. Goodrich Co., this new type aviation oil tank is capable of withstanding fire and temperatures above 2000 F without damage. The flame-resisting container, first of its kind, has a rubber-impregnated outer coating that greatly increases the factor of safety of oil cells for installations in combat aircraft. The cell is bullet-sealing as well as unusually resistant to heat and flame.



ALL-WELDED ALUMINUM TRUCK BODY

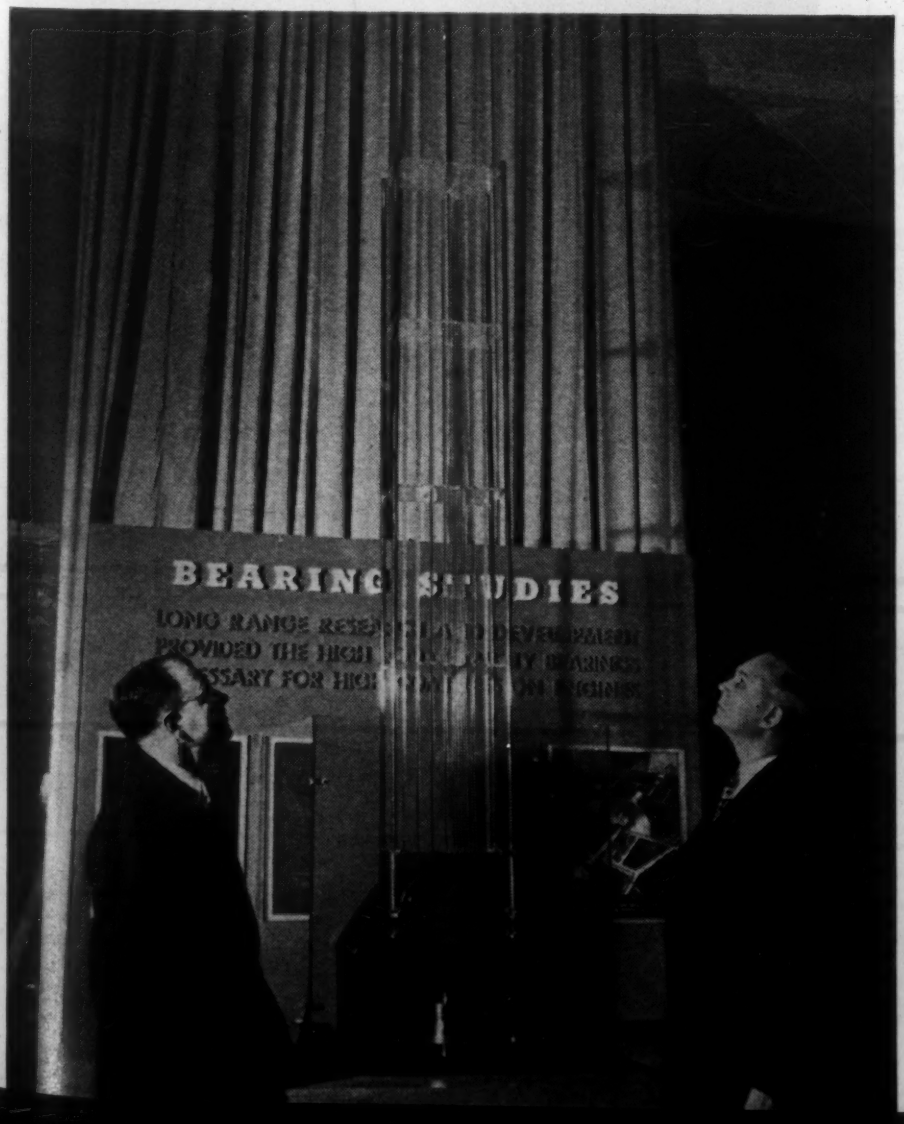
Reportedly the first of its type ever produced, this all-welded, all-aluminum bottler's truck body was recently manufactured by the Lerio Corp., Mobile, Ala. It weighs approximately half as much as a conventional steel model, and in use, has developed no structural defects despite the normal rough handling to which it has been exposed. Both riveting and gas welding were considered for the fabrication of this unit, but were rejected as impractical and costly for this particular application. After experimentation, a General Electric 200-amp. a.c. inert arc welder was used and all joints produced without oxidation or discoloration.

POWDERED BRONZE MACHINE PARTS

Compacted, sintered and coined from Super-Oilite bronze metal powder, this scavenger roll support for a spinning frame has a bearing surface between the toe and heel for a shaft that turns at 200 rpm. Lubricating oil is fed through the porous metal without danger of spotting the fabric being processed. This textile machine part was formerly produced both in cast iron and as a die casting, chromium plated, but such fabrication resulted in excessive machining and finishing costs when compared with the metal powder parts.

MOLYBDENUM SEAMLESS TUBE

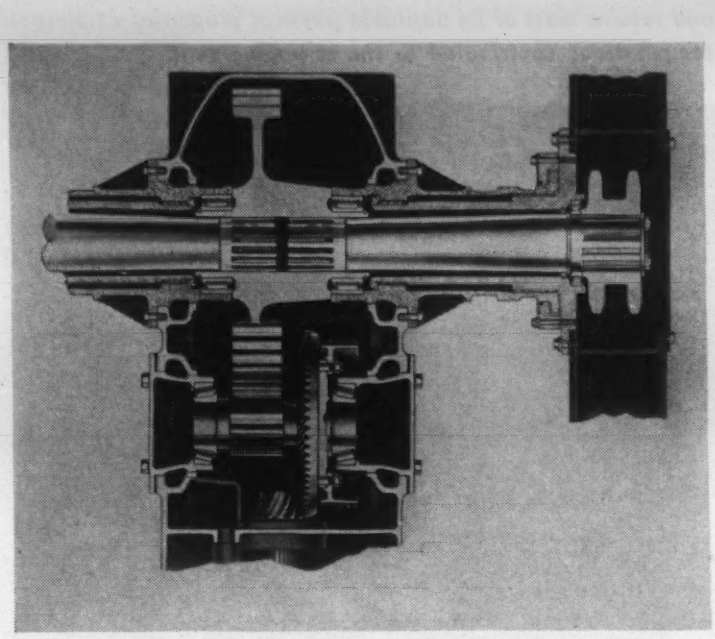
Recently produced by the Fansteel Metallurgical Corp., this extruded pure molybdenum seamless tube is believed to be the largest in the world. The tube, weighing 9750 grams, measures 2 in. outside dia., has ¼-in. wall thickness, and is 43 in. long. It was extruded from a special ingot and has a density of 10.2 gm. per cc. The fact that molybdenum has a high melting point (4757 F) and retains most of its desirable physical properties at elevated temperatures contributed to the extruding feat.



GLASS BEARING

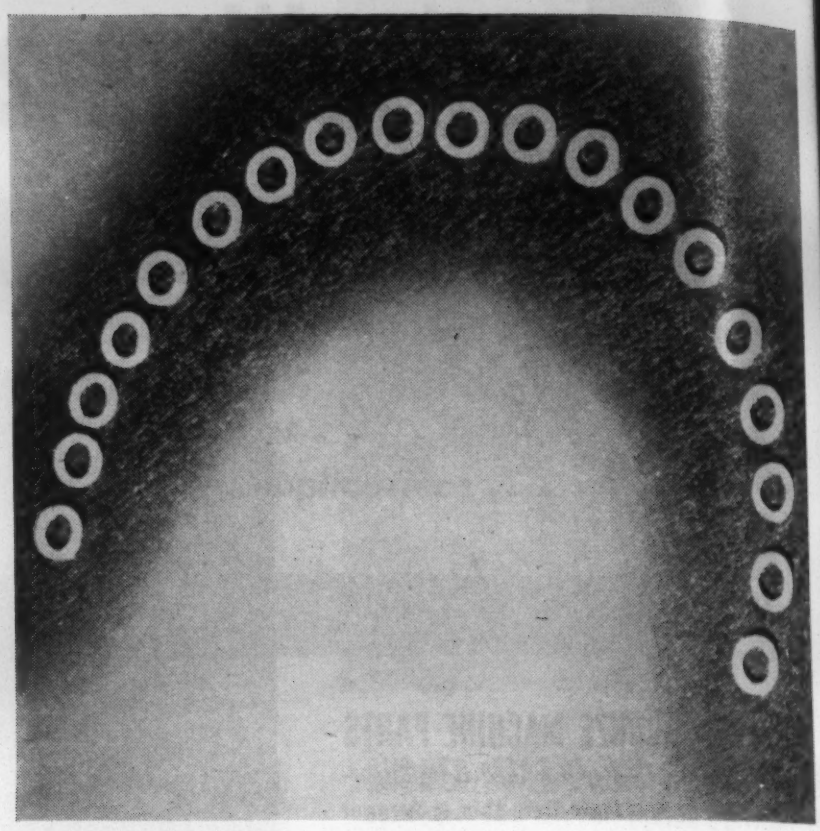
A journal bearing cut from a block of laminated glass 11½ in. long, 7¼ in. wide, and 5¾ in. high is used by General Motors to illustrate the operation of the hydrodynamic theory of lubrication. A chromium-plated steel shaft, turning within the bearing, is loaded, the magnitude of the load being visibly apparent by the oil rise in the manometers that extend above the bearing block. The glass bearing in this exhibit is 9.16 in. in dia. and was laminated of six glass sheets 1 in. thick and 16 quarter-inch sheets of glass. The sheets were joined with a transparent plastic adhesive. The block from which the bearing was made was the thickest lamination ever produced by Libbey-Owens-Ford Glass Co.

Materials at Work



NICKEL-CHROMIUM-MOLYBDENUM STEEL AXLES

High failure rate and correspondingly short service life of axles of earth-moving equipment was eliminated by the J. D. Adams Manufacturing Co. through use of type 4340H nickel-chromium-molybdenum steel. Formerly fabricated of a non-nickel-containing alloy steel, the newly-designed units are turned from a 3⅞-in. hot rolled annealed bar and then heat treated to a Brinell hardness of 375 to 415. Bearing, grease seal, and spline surfaces are then ground, followed by hobbing operations. The superior machinability of the 4340 type steel at high hardness levels has resulted in faster and more efficient production, and the properties of the alloy permit the use of higher design stresses and more uniform results from heat treatment to be achieved.

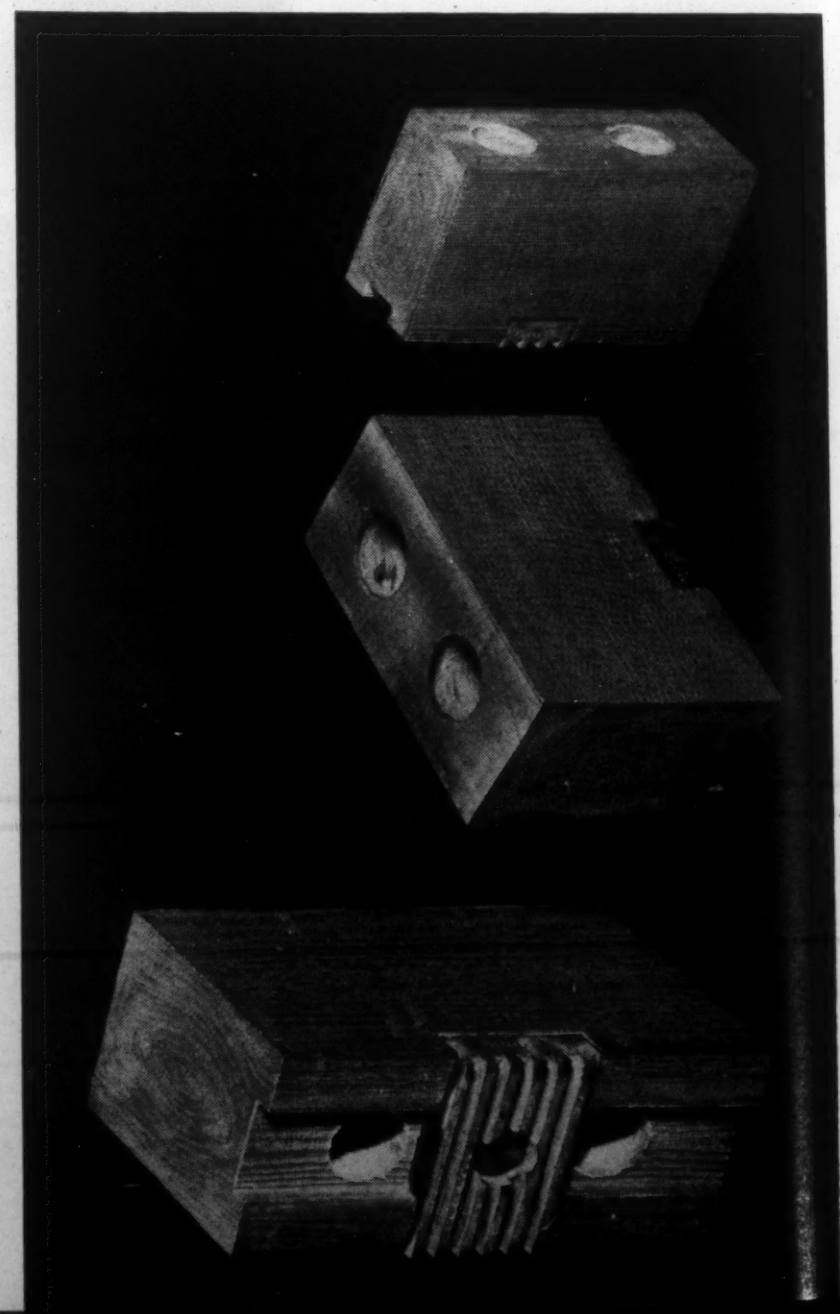


COMMUTATOR SEGMENT WASHERS

Small washers that hold the commutator segments of small motors are currently made from FM-10001 Polymer Nylon Strip by the Polymer Corp., Reading, Pa. The linen-base plastic formerly used required a large diameter washer to withstand the stresses incurred in motor assembly operations. Use of Nylon permits a reduction in the size of the washers without sacrifice of necessary strength. And in addition to neater appearance, the Nylon washers are not impaired by heat developed in the soldering of pigtails to the commutator segments.

PHENOLIC CHUCK JAWS

To eliminate marring or distortion of work surfaces, these phenol formaldehyde soft jaw blanks provide a coefficient of friction approximately twice that of standard soft steel jaws under the same pressure. The lightweight blanks are easily machined to size and are recommended for chucking either soft or finely finished materials or thin-walled sections subject to distortion under normal chucking pressures. Produced by the Gisholt Machine Co., Madison, Wis., these chuck jaws are not satisfactory for use with coolants.



Materials & Methods Manual

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This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application

Gray Iron Castings

by T. C. Du Mond, Editor, Materials & Methods

Gray iron castings are among the oldest forms in which ferrous metals are used. Despite the fact, this segment of the industry was one of the last to benefit from technological advancement. Today, however, we find gray iron castings offer unique combinations of properties not found in other materials. Moreover, these properties cover a wide range which makes necessary an intelligent selection of the proper base metal for maximum value. This manual describes the properties in gray iron castings and gives information on how to process such castings.

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Introduction

Although common usage speaks of "gray iron castings" as though gray iron were a single material such as, say, 1040 steel, this is not true. There are several cast irons whose metallurgical characteristics are similar but the properties of which cover an extremely wide range. Since irons in the gray iron group offer tensile strengths varying from 20,000 psi. minimum up to over 60,000 psi. minimum, it can readily be seen why in general all inclusive statements cannot be made about "gray iron castings."

Perhaps it might be best, first of all, to define cast iron. Cast iron is essentially an alloy of iron, carbon and silicon, with carbon present in excess of the amount which can be retained in solid solution in austenite at the eutectic temperature. Alloy cast iron contains other elements in sufficient quantities to change properties measurably.

From this it is but a short step to a definition of gray iron. Gray cast iron contains a relatively large percentage of carbon in the form of graphite and the remainder of the carbon in the form of eutectoid carbide. The name is derived from the fact that cast iron of this general type exhibits a gray fracture when broken.

Gray cast irons usually fall within the following chemical range: 1.00 to 2.75 silicon, 2.70 to 3.60% total carbon, and manganese and phosphorus in minute to small quantities.

In addition to other methods of defining gray iron, it has been called steel plus graphite. In the cast iron, graphite is in the form of small flakes, and are in effect weak spots or voids in a steel matrix. By carrying on the analogy, then, gray iron is steel with small voids scattered throughout.

Unlike other materials, gray irons are generally specified according to tensile strength rather than by chemical composition. The A.S.T.M. recognizes this fact, and therefore avoids the setting up of chemical specifications for gray irons.

At one point in their history, gray irons were chosen primarily because they were cheap, easy to cast and readily machinable. Now, however, these materials are specified on the basis of their properties, some of which are not obtainable in other materials and others only in much more expensive materials.

Gray iron castings combine low cost melting and molding with ease of casting into intricate shapes. They offer good rigidity, compressive strength and excellent machinability. The latter property is less of a feature in the gray irons of higher tensile strength, although still rating as good.

The structure and strength of gray iron castings are controlled largely by the compositions of the iron and the cooling rate. While cupola charges for melting can be controlled, most of the variables in properties come about through the rate of cooling. Generally speaking, the slower the cooling rate, the lower the physical properties.

Cooling rates are affected by section and size of casting and, to a degree, the metal's pouring temperature. In view of the fact that section is important to cooling rate, it is understandable that a casting with various sections may show a variety of physical properties. Although compositions can be varied to reduce somewhat the effects of section sizes, design is probably the most satisfactory control.

For years the foundry industry had the reputation of being one of the oldest but least scientific of industries. During and since the last war, castings have had to compete with other materials and other fabricated parts. Hence, many, indeed most foundries have modernized their methods and now rely on precise control to provide castings which will perform as the customer orders.

In addition to the seven standard gray irons, there are several controlled irons which offer added properties not found in the standard materials. In addition, there are alloy irons, which, basically, are gray irons to which have been added one or more elements to provide specific service characteristics. As a general rule, the higher the properties of any type, the more costly the casting. In accordance with this, the lower the class of iron (lower strength) the lower the cost.

As the class of iron goes up, the difficulty of casting increases, accounting to a large extent for the increased cost.

As this manual was under preparation nodular graphitic cast iron reached the first commercial stages. At this time complete data is lacking on such cast irons, although indications are that tensile strength can be doubled and other properties bettered by producing the iron with the graphite in nodular form rather than as flakes. The form in which graphite appears is promoted by additions of magnesium or cerium.

This manual will confine itself largely to the standard gray irons, with occasional references to the special irons, controlled irons, alloy irons and other variations from the standard.

The gray iron foundry industry is second only to the rolled steel industry in the engineering materials field. During 1948, approximately 12.5 million tons of gray iron castings were produced. More than 3,000 foundries in the United States produce gray iron castings for sale or for their own use. These facts serve to illustrate the importance and widespread use of gray iron castings.

Properties of Gray Iron Castings

As has often been stated, gray iron offers a combination of properties that is not to be found in any other material group. It was not too long ago that gray iron was chosen because it was cheap and easy to cast and despite the fact that low tensile strengths were the standard, as was extreme brittleness. New gray iron castings, through better control and foundry procedures, are able to compete with castings of other materials on the basis of their ability to do the job best and most economically.

The principal physical characteristic specified in gray iron castings is the tensile strength. Tensile strength in gray irons is controlled largely by the form in which graphite appears in the solidified metal as well as the distribution of the graphite. Tensile strengths ranging between 10,000 and 60,000 psi. can be produced in gray irons by controlling the arrangement, size and amount of graphite flakes. Graphite distribution and amount is determined first of all by the total carbon in the iron and then by the cooling rate of the casting.

Some materials engineers use a formula to evaluate the quality of a cast iron in accordance with its chemical composition. The formula, known as the "carbon equivalent" formula, follows:

$$C.E. = T.C. + \tfrac{1}{3}(Si + P)$$

C.E. is the carbon equivalent or quality rating. T.C. is total carbon. Si and P, of course, represent silicon and phosphorus. The lower the carbon equivalent, the higher the hardness and mechanical properties can be expected to be.

In interpreting equivalents determined by the formula, the following rules are used:

1—Low C.E. irons show less change in hardness at various cooling rates.

2—Low C.E. irons have less change in hardness in different section sizes.

3—Low C.E. irons give higher hardness and tensile strength in different section sizes.

4—By varying the cooling rate or section size with the C.E. constant, the tensile strength and Brinell hardness will vary directly.

Tensile Strength—The majority of gray iron castings are furnished to specifications calling for tensile strengths falling between 25,000 and 50,000 psi. However, ASTM specifications class gray irons in seven groups with properties ranging from 20,000 psi. minimum to 60,000 psi. minimum tensile strengths. Special gray iron castings having up to 100,000 psi. have been provided, but their use is limited.

Tensile strength of a gray iron casting is determined by a test bar not attached to the casting. Size of the test bar varies with section thickness, since the mass of this type casting has considerable influence on the tensile properties.

Generally, it is difficult if not impossible to attain castings of the higher strength classes if thin sections are involved. However, nearly any required strength can be provided if design changes can be made. The usual minimum section thickness for the various classes of gray irons is included in the accompanying table.

At room temperatures it is safe to assume

Many of the piston rings for automotive engines are made of gray iron. Here stacks of molds are being filled in the foundry of the American Hammered Piston Ring Div., Koppers Co.

Class	Tensile Strength, Min. Psi.	Usual Min. Wall Thickness, In.
No. 20	20,000	1/8
No. 25	25,000	1/8
No. 30	30,000	1/4
No. 35	35,000	3/8
No. 40	40,000	1/2
No. 50	50,000	1/2
No. 60	60,000	3/4

Size of Section, In.	Nominal Dia. of Test Bar, In.
0.50 and under	0.875
0.51 to 1.00	1.20
1.01 to 2.00	2.00
over 2.00	Larger bars by agreement between manufacturer and purchaser

that gray irons have a long time strength or tensility equal to 80% of the short time tensile strength. This means that a gray iron having 40,000 psi. tensile strength could stand indefinitely a static load equivalent to a stress of approximately 37,000 psi. without distortion or breakage.

All gray irons retain their tensile strength properties at temperatures up to 450 F, and many operate satisfactorily up to 650 F.

Strength properties of gray iron castings are affected by heat treatment. Stress relief annealing of castings which are likely to have internal stresses is helpful, while full annealing and slow cooling will reduce tensility.

Hardness—There is a direct relationship between the tensile strength and the hardness of gray iron, as there is with steel, although the relationship is subject to variation in accordance with foundry practice. Therefore, while hardness increases as the tensile strength goes up, it is not safe to assume that by specifying one property the other one will be assured. Minimum values should be given for both properties.

Unlike the case of steel, hardnesses of gray irons do not have a relationship to ductility and compressive strength.

Commercial gray iron casting (nonalloy) range in hardness from 150 to 260 Brinell. The Brinell hardness number in fully annealed castings may range between 100 and 140.

It is possible to increase the hardness of gray iron castings through heat treatment, although such processing usually is provided to achieve other properties.

Compressive Strength—Gray iron castings are stronger in compression than in tension, with compressive strengths running as high as 4½ times the tensile strengths. The ratio cited is for the iron of lower strengths, with the ratio falling down to about 2.5:1 in the stronger irons. On this basis, compressive strengths range from 65,000 psi. up to 170,000 psi.

Speaking comparatively, gray irons offer compressive strengths that are better than most nonferrous alloys, greater than those of the usual normalized cast steel, and on a par with alloy steel that has not been heat treated.

This property makes gray iron well suited

Automotive Type Cast Iron

Physical Properties[1]

SAE No.	Hardness BHN	Transverse Lb., Min.	Deflection In., Min.	Tension Psi., Min.
110	187 Max.	1800	0.15	20,000
111	170-223	2200	0.20	30,000
120	187-241	2400	0.24	35,000
121	202-255	2600	0.27	40,000
122	217-269	2800	0.30	45,000

[1]*Properties determined from arbitration test bar (1.2-in. dia., broken on 18-in. supports).*

SAE 110 Miscellaneous soft iron castings (as cast or annealed) in which strength is not of primary consideration.

SAE 111 Small cylinder blocks, cylinder heads, air cooled cylinders, pistons, clutch plates, oil pump bodies, transmission cases, gear boxes, clutch housings, light weight brake drums, etc.

SAE 120 Automobile cylinder blocks, cylinder heads, flywheels, truck brake drums, cylinder sleeves, cylinder liners, pistons, etc.

SAE 121 Truck and tractor cylinder blocks and heads, heavy flywheels, tractor transmission cases, differential carrier castings, heavy gear boxes.

SAE 122 Diesel engine castings, liners, cylinders, pistons, and heavy parts in general.

for use in stamping and forming dies where loads are largely compressive. Gray iron castings are used for die shoes and supporting sections for use with dies of other materials such as cemented carbides and hardened steels.

Shear Strength—Shear strength tests are often used to test the quality of a gray iron casting, with specimens taken directly from the casting. In these castings the shear strength is equal to the tensile strength in the high strength gray irons. In the irons of lower strength, the shear strength often is up to 1.6 times the tensile strength.

Yield Point—Gray irons exhibit no sharp yield point, proportional limit or elastic limit. Therefore, there is no straight line result in a stress-strain diagram. Gray irons can generally sustain a load of 80% of the tensile strength without perceptible creep. However, there is a slight amount of creep even under small loads. Where such creep might interfere with proper functioning of parts, it can be overcome through advance treatments. In these properties, gray iron is roughly comparable to low alloy steel.

Fatigue Strength—The fatigue strength (endurance limit) of gray irons can be figured at approximately 40 to 55% of the tensile strength, varying linearly. Tied in with this property is the notch sensitivity, which is much less for gray iron than for steel.

In many cases the actual reduction in endurance limit caused by mechanical notches is much less than expected by computation.

One explanation of the low notch sensitivity is that since graphite in the gray iron creates so many discontinuities, the addition of a mechanical notch will have little additional effect in concentrating stresses. This theory is borne out to some degree by the fact that the gray irons of higher tensile strength are more sensitive to the notch effect than are the lower tensile strength grades.

Modulus of Elasticity—The effective modulus of elasticity of gray irons is computed at 25% of the ultimate strength and range from a minimum of 12,000,000 psi. up to more than 18,000,000 psi. The values increase in direct relationship to the tensile strength of the iron. However, there is no well defined elastic limit for a gray iron.

Coefficient of Expansion—Although the coefficient of expansion varies somewhat according to the carbon content of the gray iron, a value of 0.000010 per deg. C is considered sufficiently accurate for normal temperature changes. This value is about twice that of steel.

Service Characteristics of Gray Iron Castings

Gray iron castings have many favorable service characteristics. Several of these are about on a par, depending upon the end use to which the castings are put. Producers of gray iron cite these properties in their materials—a combination not found in any other competitive material:

High wear and abrasion resistance
High corrosion resistance and durability
Machinability
High damping capacity
High heat resistance
High rigidity
Low thermal expansion

These properties will be taken up and discussed separately.

Wear Resistance—Gray iron is outstanding in its resistance to wear from sliding friction. For this reason castings of the material are used universally for internal combustion engine cylinders and cylinder liners. The wear resistant property is attained, at least in part, by the graphite peculiar to gray iron. The graphite serves as a lubricant and minimizes galling.

There is, as yet, no positive proof of why gray iron resists wear so well. However, since those irons which contain a random distribution of graphite in a matrix which contains no free ferrite best provide this property, the belief is that the microstructure is the most important guide to wear resistance. Nevertheless, many buyers of gray iron castings for applications involving wear specify Brinell hardnesses in excess of 190.

For some applications the gray iron castings are hardened through heat treatment to increase the wear resistance.

For metal-to-metal contact, where lubrication is lacking or uneven, gray iron serves well. The metal against which it moves can be either itself or almost any other metal. Gray iron might cut some softer alloys but generally works satisfactorily with material as hard or harder than itself.

Corrosion Resistance—While ordinary gray iron castings are not intended for highly corrosive service, their resistance to corrosion is better than carbon steels and some low alloy steels. Gray iron water mains have been in service for as long as 100 years. Although a coating of rust will form on gray iron in moist atmospheres, subsequent rust penetration is slow. This condition is true, at least in part, to the layer of graphite flakes below the surface.

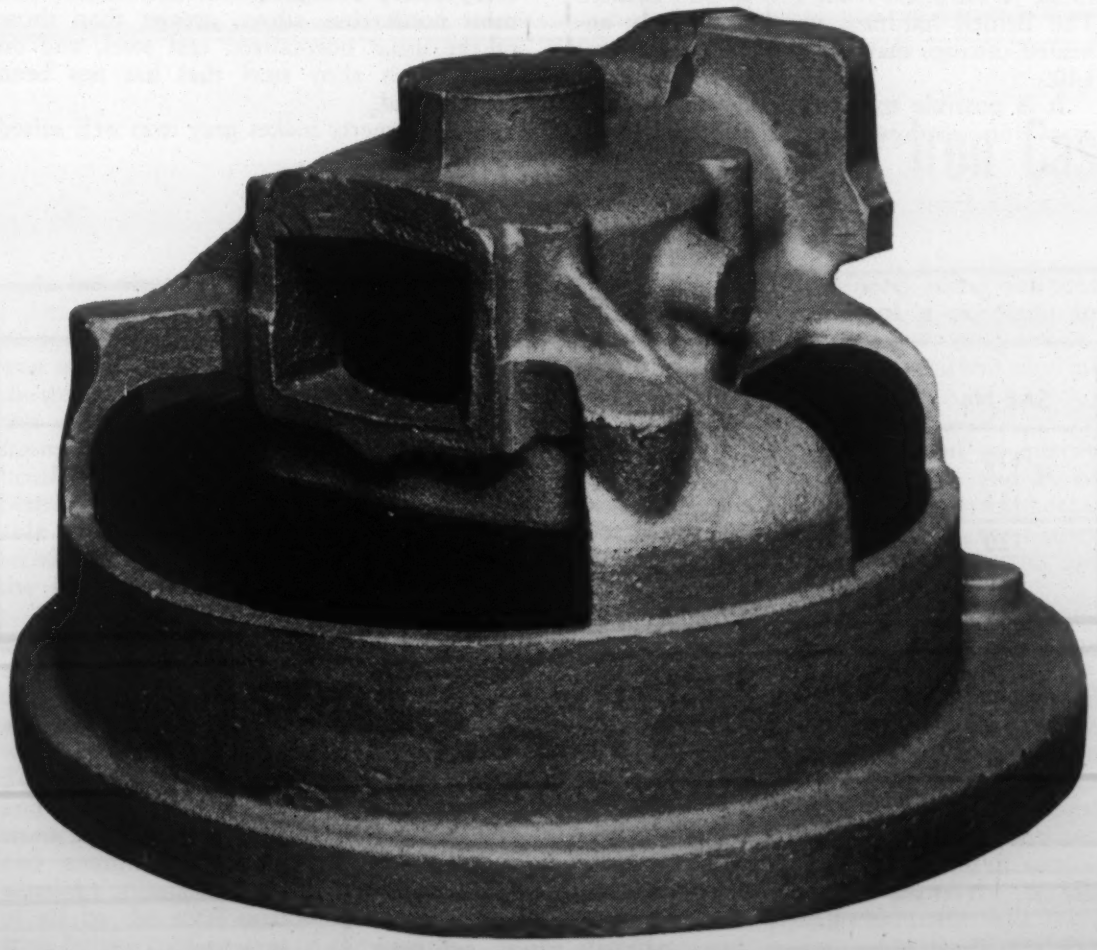
Gray irons are resistant to strong sulfuric, phosphoric and nitric acids, but are attacked by dilute solutions. Likewise, they resist many alkaline and caustic solutions such as lye, soda ash and ammonia. The close grained types of gray irons are most resistant to corrosive attack. These are the irons in the 30,000 to 40,000 psi. tensile strength classes.

Because of their resistance to the corrosive effects of alkaline fluids, gray iron castings find wide use in the petroleum, glass, soap, viscose rayon, dyestuffs and paper manufacturing fields.

As another indication of corrosion resistance there is the fact that gray iron has been used for heads, cylinder liners and blocks in salt cooled internal combustion engines for many years.

Where extreme corrosive conditions or contact with corrosive media at elevated

Now through developments of the Eaton Manufacturing Co., gray iron can be cast centrifugally with a general increase in properties and finish.



temperatures is anticipated, special grades and alloy cast irons should be used.

Damping Capacity—One of the reasons gray iron is so valuable for use in flywheels, crankshafts, camshafts and similar parts subject to vibration is that material's capacity to absorb or "dampen" such vibration. This property is found in gray iron to a greater degree than in any other common engineering material. Energy absorbed per cycle in gray iron is about 10 times that of steel.

The damping property in gray iron is often demonstrated by striking the casting with a hammer. The result will be a dull thud. A similar blow on steel will produce a distinct ringing sound. Graphite is believed to be the reason why gray iron has this damping property, since the graphite serves as a large area of voids in the structure which, in turn, permit the metal structure to deform.

It has been determined that the lower the tensile strength in gray irons, the greater is the damping capacity. In other words, the stiffer the iron the less is its capacity to absorb vibration.

There is no widely accepted method of using the damping capacity in design, but it is well to know that the property is available. Effective strength of a part may be much greater with a high damping capacity and only fair strength than would be true if the reverse were the case.

Machinability—Although gray iron castings are generally reputed to be highly machinable, this is not necessarily so. Gray irons cover such a wide range of composition, structure and mechanical properties that generalizations should not be made.

The lower strength gray irons possess the best machinability, although the quality of finish attained depends upon the grain structure. A coarse-grained gray iron will result in a pitted surface caused by metal tearing away from the graphite during the cutting. Good finishes are attained in fine-grained material.

The easiest gray iron to machine is that which has been cast in permanent molds and then fully annealed. Some of the difficulty in machining gray irons that normally would be easy to machine is caused by carbides, chill spots and hard edges. All of these conditions can be avoided by proper design, molding techniques and control.

Heat Resistance—The ordinary unalloyed gray irons exhibit a remarkable stability over a wide temperature range. Depending upon the application, gray iron castings can be used at temperatures up to 650, 850 and 1200 F.

Although many engineering codes do not permit the use of gray iron for pressure vessels at elevated temperatures, ASTM specifications now indicate the use for pressure vessels at temperatures up to 650 F.

Gray irons show no more than a slight loss of strength up to 800 F, although a sharp drop occurs above 900 F. Below 800 F, the materials maintain their hardness, wear resistance and fatigue limit, although the compressive strength drops somewhat.

As with any ferrous material, oxidation is likely to result at high temperatures, particularly in the presence of some corrosive media.

At higher temperatures, gray irons are likely to increase in volume, particularly when subjected to repeated heating and cooling cycles. This characteristic is known as growth and is thought to result from chemical changes in the irons. Growth causes a serious loss in strength and a great increase in brittleness.

Engineering Properties of Gray Iron

Class	30	35	40	45	50	60
Tensile strength, psi. (min.)	30000	35000	40000	45000	50000	60000
Transverse strength, load, lb.	2200	2400	2600	2800	3000	3400
1.2-in.-dia. bar, deflection, in.	0.20	0.20	0.22	0.22	0.24	0.26
Compressive strength, psi.	105000	115000	125000	135000	150000	175000
Torsional strength, psi.	40000	45000	54000	60000	67000	76000
Modulus of elasticity[b], psi. $\times 10^{-6}$	14	15	16	17	18	19
Torsional modulus, psi. $\times 10^{-6}$	—	—	5.5	6.6	7.0	8.0
Impact strength, Izod AB (1.2-in.-dia. unnotched) ft.-lb.	23	25	31	36	65	75
Brinell hardness	180	200	220	240	240	260
Endurance limit, psi. Smooth	15500	17500	19500	21500	25500	27500
Notched	(13500)	(15500)	17500	(19500)	21500	23500
Damping capacity	Excellent	Excellent	Excellent	Good	Good	Good
Machinability	Excellent	Excellent	Excellent	Good	Good	Fair
Wear resistance	Fair	Fair	Good	Good	Excellent	Excellent
Pressure tightness	Fair	Fair	Good	Good	Excellent	Excellent
Specific gravity, lb. per cu. in.	0.254	0.258	0.262	0.267	0.269	0.270
Thermal coefficient of expansion: (50-200 F) (in. per in.) $\times 10^{-6}$	6.5-6.7	—	6.6-6.8	6.4-6.4	—	—
(50-500 F)	6.9-7.2	—	7.1-7.3	6.8-7.0	—	—
(50-800 F)	7.4-7.6	—	7.4-7.6	7.0-7.2	—	—
Coef. of friction (against steel)	—	—	—	(0.19)	(0.195)	(0.20)

Note: Values in ( ) estimated. [b] *At 25% of tensile strength.*

Growth rarely occurs at temperatures below 600 to 700 F unless certain corroding agents such as superheated steam are present. In certain grades, particularly the coarse-grained types, the growth and consequent loss of strength can come at lower temperatures. In some cases, the permanent effects of growth, at least as far as size is concerned, are offset by heat treatments prior to final machining.

Properties at Low Temperatures—Gray iron castings retain their properties to extremely low temperatures. Tests have been carried on to temperatures down to —317 F. In some cases tensile strength and hardness showed a slight increase, but there was no increase in brittleness. Below —112 F tests show a slight decrease in impact value.

This property, together with the high temperature property, shows gray iron to be relatively stable over a temperature range of 1170 degrees—from —317 to 800 F.

Brittleness and Impact Strength—Gray iron castings are not generally recommended for applications where impact or shock resistance are required to a great degree. Gray iron is much more brittle than steel and is marked by a much more distinct fracture than steel. Izod and Charpy impact tests both show this.

Although there is no definite relationship between shock resistance and tensile strength, in general those gray irons having the higher tensile values also provide better impact properties.

The impact value must be interpreted properly for any given application. For example, if a steel and a gray iron were both under consideration for a given application, the steel would likely be chosen if impact strength were the determining factor. However, it is entirely possible that although the gray iron would fracture under a certain set of conditions the steel would permanently deform to such an extent under the same conditions that it would be useless.

Electrical and Magnetic Properties—The specific resistance of gray iron is generally high, although certain alloying elements may alter this property. Gray iron resistance grids are used frequently in rather high electrical circuits, since this material is the lowest cost obtainable for a given thermal dissipation capacity.

Gray irons are magnetic, with the best magnetic properties found in ferritic irons where graphite is in nodular form. Flake graphite lowers the degree of magnetism attainable because the flakes act as voids which provide areas where demagnetizing forces are set up.

Thermal Conductivity—Although thermal conductivity is not one of the outstanding virtues of gray irons, this property is relatively good at lower temperatures. Conductivity decreases as the service temperature rises, reaching a low value at 750 F. An increase in precipitation of graphite such as is attained by annealing increases conductivity. The ferritic gray irons offer the best conductivity properties.

Summary of Gray Iron Specifications

GENERAL CASTINGS

Specifying Body	Spec. No.	Class	Required Chemistry %S Max.	%P Max.	%C	%Si	%Mn	Others	Tensile Strength Psi.	Minimum Physical Properties[4] Transverse Properties 0.875-in. Bar Str. Lb.	12-in. Span Def. In.	1.2-in. Bar Str. Lb.	18-in. Span Def. In.	2.0-in. Bar Str. Lb.	24-in. Span Def. In.	Brinell Hardness Max.	Uses
ASTM	A48-48[1]	20	Not specified[2]						20,000[3]	900	—	1800	—	6000	—	—	Gray iron castings
		25							25,000	1025	—	2000	—	6800	—	—	
		30							30,000	1150	—	2200	—	7600	—	—	
		35							35,000	1275	—	2400	—	8300	—	—	
		40							40,000	1400	—	2600	—	9100	—	—	
		50							50,000	1675	—	3000	—	10,300	—	—	
		60							60,000	1925	—	3400	—	12,500	—	—	
ASTM	A190-47	—	Not specified							Determined only at request of purchaser						[5]	Lightweight and thin-sectioned castings
Federal	QQ-1-652	20-60 Special	Not specified						Identical with ASTM Spec. A48-48[6, 7]	—	—	—	—	—	—	—	Iron, gray; castings
Navy	46-1-6c	Light	0.12	—	—	—	—	—	18,000[6, 8]	—	—	—	—	—	—	—	Iron, gray; castings
		Medium	0.12	—	—	—	—	—	21,000	—	—	—	—	—	—	—	
		Heavy	0.12	—	—	—	—	—	24,000	—	—	—	—	—	—	—	
Navy	46-1-5c	A	0.12	0.20	—	—	—	—	30,000[6, 8]	—	—	—	—	—	—	250	Iron, gray; high test; castings
		B	0.12	0.20	—	—	—	—	35,000	—	—	—	—	—	—	260	
		C	0.12	0.20	—	—	—	—	40,000	—	—	—	—	—	—	270	
		D	0.12	0.20	—	—	—	—	45,000	—	—	—	—	—	—	280	
ABS	40-93	—	Not specified						20,000[9] (Substantial agreement ASTM A48-48)	—	—	—	—	6000	—	—	Gray iron castings

AUTOMOTIVE CASTINGS

ASTM	A159-47	110	Not specified but ranges suggested						20,000	—	—	1800	0.15	—	—	187	Automotive gray iron castings
		111							30,000	—	—	2200	0.20	—	—	170-223	
		120							35,000	—	—	2400	0.24	—	—	187-241	
		121							40,000	—	—	2600	0.27	—	—	202-255	
		122							45,000	—	—	2800	0.30	—	—	217-269	

PRESSURE-CONTAINING CASTINGS FOR USE AT HIGH TEMPERATURES

ASTM	A278-44T	40	0.12 0.25 C.E. = 3.8% max.[9a]						40,000[10]	—	—	—	—	—	—	—	Gray iron castings for pressure-containing parts for temp. up to 650 F
		50	C.E. = % Total C. + 0.3 (%Si + %P)						50,000	—	—	—	—	—	—	—	
		60							60,000	—	—	—	—	—	—	—	

NON-PRESSURE CONTAINING CASTINGS FOR USE AT HIGH TEMPERATURES

			Recommended Max.	Max.	Min.	C.E.		
ASTM	A319-48T	I[10c]	0.12	0.60	3.5	3.81/4.4	—	Superior thermal shock resistance, low to moderate tensile strength Average thermal shock resistance, moderate tensile strength up to 30,000 psi. Higher tensile strength than Classes I or II (up to 40,000 psi. may be specified)	Gray iron castings for elevated temperatures for non-pressure containing parts
		II[10c]	0.12	0.60	3.2	3.51/4.1			
		III[10c]	0.12	0.60	2.8	3.2/3.8			

GRAY IRON ALLOY CASTINGS (SCALE RESISTING)

Navy	46-1-9	—	0.10	0.20	2.6/3.0	1.25/2.20	0.8/1.3		25,000[8, 8a]	—	—	—	—	—	—	120-180	Iron, gray, alloy; castings (scale-resisting)
			Ni 12.0/15.0		Cr 2.0/3.5		Cu 5.0/7.0										

[1] *This is a basic specification used by AAR, API, AREA, ASME, NBFU, SAE and others.*

[2] *Chemical analysis in most gray iron specifications subordinated to physical properties, but may be specified by agreement between manufacturer and purchaser.*

[3] *Tensile test preferred, transverse tests optional.*

[4] *Test bar normally based on controlling section of casting according to following table:*

Size of Section—In.	Nominal Dia. of Test Bar—In.
0.50 and under	*0.875*
0.50 and 1.00	*1.20*
1.01 to 2.00	*2.00*
2.00 and over	*Larger bar by agreement*

[5] *Shall be machinable at locations designated by purchaser.*

[6] *If specified in invitations for bids, castings and test bars requiring dimensional stability shall be stress-relief annealed.*

[7] *Special class for cases where required properties are not covered by Classes 20-60.*

[8] *Tensile test coupons to be cast attached to casting if practical and not injurious to either. As alternate procedure, specimen should be cast attached to special block. Dimensions tensile specimen correspond to ASTM A124-39 (discontinued by ASTM in 1939).*

[8a] *Castings may be annealed by heating to 1750 F and cooling in air or quenching in oil.*

[9] *Surveyors will accept gray iron to other specifications if approved in connection with design.*

[9a] *All irons may be alloyed to stabilize structure for elevated temperature service.*

[10] *Castings and test bars shall be stress-relieved previous to test (Sec. 2b ASTM Spec. A278-44T).*

[10c] *If alloyed with chromium in the indicated ranges, each class shall be further subdivided into the following "Types": A-0.20/0.40; B-0.41/0.65; C-0.66/0.95; D-0.96/1.20%. All classes may be further alloyed.*

Prepared by Gray Iron Founders' Society Technical Dept.

Processing Gray Iron Castings

Although new techniques in casting, including better control over all phases of the operation, have reduced somewhat the need for further processing of gray iron castings, some work must be done on every casting. Principal processes involved are cleaning and finishing, heat treating and welding.

Finishing

While most castings are used in their natural state, after cleaning, it is sometimes desirable to provide a special finish. Castings can be japanned, enameled, galvanized and painted by the processes which are well known to the ferrous metal field.

On the other hand, practically all gray iron castings require one or more cleaning operations. Wire brushing, tumbling, sand and shot blasting are all invoked, the exact process being largely dependent upon the size and quantity of castings to be cleaned.

Although not as commonly used as the other cleaning processes, pickling is occasionally used.

The cleaning methods enumerated are used primarily for the removal of embedded sand and shop dirt. For use of the casting in the unfinished state, these steps are sufficient. However, if a protective or decorative finish is to be applied, degreasing and/or alkaline cleaning will be necessary to assure a good, long-lived finish.

Machining

Along with cleaning, almost every gray iron casting requires some machining. If nothing else, the machining may be just a simple grinding operation to remove parting lines and gate and riser marks. Practically all of the common machining methods can be used on gray iron castings, but all require care in application to attain most satisfactory results.

Gray iron has the reputation of being highly machinable. This reputation is sound, but machinability decreases in the stronger ordinary gray irons and in many of the alloy irons. Therefore, it is not practical in a treatise of this type to do more than give general rules covering machining practice. Definite cutting speeds and feeds can be readily determined for castings being processed in quantities.

In machining gray iron castings, the character of the finish, both as to accuracy and finish, is controlled by many factors. In the first group are included depth of cut, feed, shape of cutting tool, and the speed at which cutting is done. Secondly, there must be considered rigidity of the machine tool, the stiffness of the actual cutting tool, and flexibility in the casting. Finally, there must be considered the quality of the cutting tool. Carbide tools provide the best finish and ordinary carbon tool steels the least satisfactory finish.

As might be gathered, anything which might cause movement of tool or work will result in chatter, inaccurate machining and relatively poor surfaces.

When machining castings, care must be taken to avoid any movement of the work. This means that proper jigs and fixtures must be used, or that strong holding devices be employed where quantities involved do not justify special fixtures. Too, if the portion to be machined is thin, there is a possibility of the work deflecting under tool pressure. Therefore, backing plates or some suitable bracing is required for best machining results.

When castings made from coarse grained gray irons are machined, it is almost impossible to attain a smooth finish. Hard metals in the casting pull out from the graphite and leave small pits. Some users of castings minimize this condition by a final grinding operation. Good finishes are easily attained in the close grained gray irons, especially when carbide tools are used.

It is generally advisable to give the castings an annealing heat treatment prior to machining. A stress-relief anneal will help prevent distortion which sometimes occurs during machining. A full anneal will appreciably lower hardness of the casting and make machining easier.

When heat treating is anticipated, it is often wise to rough machine the casting before the heat treatment and give it a final grind to size after. This will provide for any growth which might have taken place.

Heat Treating

Gray iron castings are comparable in their reactions to heat treating with steel parts subjected to those same treatments. The difference lies in procedures.

Gray irons that are low in silicon content respond best to heat treatment. Satisfactory hardening requires that in melting for the casting close control has been exercised over silicon content and demands close control over heat treating temperatures.

Three classes of treatments involving heat are applied to gray iron castings. These are:

Stress relief annealing
Full annealing
Hardening

Stress Relief—Aging, normalizing, mild annealing are all used to identify the operation, but stress relieving is a more accurate designation of the process.

Castings are heated to a temperature between 800 and 1100 F for a varying time period, depending on the heaviest section. A safe rule to follow is to allow the casting to remain at top heat for 1 hr. per in. of heaviest section. The casting is then allowed to cool slowly in the furnace.

Stress relief annealing results in a slight decrease in hardness of the gray iron, very little decomposition of cementite, and a slight change in tensile strength at room temperature.

When it is known that the casting is to be enameled or galvanized, a low temperature anneal can be employed. The chief purpose of this type of anneal is to drive out gases entrapped in the casting.

Annealing—Gray iron castings are annealed in order that they be softened enough to simplify machining. A completely annealed unalloyed gray iron casting will have a Brinell hardness of 120 to 130. In addition to softening the metal, annealing results in a reduction in strength. Both of these changes result from a reduction in the combined carbon and an increase in graphite content.

Annealing is commonly done in the temperature range of 1400 to 1500 F, although a range of 1200 to 1250 F is also used. As in stress relieving, castings should be held at the ultimate heating temperature for a period equivalent to 1 hr. per in. of section thickness.

Hardening—Hardening of gray iron castings through heating to above the transformation point, quenching and drawing will increase the hardness and wear resistance and approximately double the tensile strength. However, this treatment can only be applied to castings of simple shape.

Those gray irons nominally included in the "soft irons" group are not customarily hardened, although they can be hardened to a martensitic structure. The soft irons require longer times at temperature as well as higher temperatures to obtain the desired carbon content in the austenite.

As-quenched castings have lower tensile strengths than when in the as-cast condition, although this property as well as impact strength are helped greatly by subsequent tempering.

Heating prior to quenching is slow and uniform until a temperature between 1500 and 1600 F is reached. After soaking—holding at heat for 1 hr. per in. of heaviest section—the casting is quenched. Quenching is usually done in oil, although occasionally water and less frequently air is used as the medium.

After quenching, at which point extreme hardness is reached, the casting should be tempered. Softening proceeds uniformly as the tempering temperature is increased above 350 F. As mentioned, strength and impact properties are improved by tempering. Wear resistance in quenched and tempered castings is from 2 to 7 times that of an untreated casting. Cylinder liners heated for hardness and wear resistance show a Brinell hardness of 375 to 500.

Methods of Heat Treatment—Practically all of the usual heat treating equipment commercially available can be used in treating gray iron castings. Flame hardening and induction hardening are both used for localized hardening for wear resistance. Austempering is often applied by heating to between 1500 and 1600 F and quenching in a molten salt bath at 500 to 550 F for from 15 min. to 1 hr., depending upon the size of the casting.

Welding

Welding is frequently required on gray iron castings. Welding is used primarily as a means of repairing or reclaiming defective castings, rather than as a joining method. Several casting methods are commonly used. Special techniques or special welding rods are required.

Except in those instances where the metal structure does not matter can preheating of the casting be avoided. Arc welding and gas welding require a preheat and postheat of the castings. Otherwise difficulty will be encountered in machining the weld area and undesirable localized stresses will be set up.

A so-called cold weld uses pure nickel rod which is heated to a mushy temperature and then deposited into defective areas. This method is only used for relatively small areas.

Gas Welding—For gas welding, the cast-

Prepared by Gray Iron Founders' Society Technical Dept.

ing is heated to a dull red heat and welded while hot with a cast iron rod which has a high silicon content. The rod should have approximately the same chemistry as the casting. A suitable flux must be used for removing oxides. When the weld is completed, the casting is permitted to cool slowly to room temperature. A weld so produced will be strong as well as machinable.

Arc Welding—When arc welding is used on gray iron castings, preheating is desirable. Preheating speeds the actual welding operation, relieves stresses, helps to retain the characteristic structure of the base metal, avoids formation of unmachinable spots, and helps offset a tendency towards cracking. Castings thinner than ¼ in. are seldom welded because of the difficulty in avoiding cracks in hard areas.

For arc welding, special welding rods are available, both coated and uncoated. Welding is done by the use of a low current, and deposition of weld metal should be intermittent. One head should be permitted to cool and be peened slightly before the next head is laid. These steps reduce the hardening effect. After welding, the part should be annealed.

Where strength is secondary to the machining characteristics, a 67% nickel rod can be used. The use of such a rod provides a good color match, where appearance is important.

Bronze Welding—Little preheating is necessary for bronze welding, but if, in gas welding, the base metal temperature is raised to about 1500 or 1600 F, the copper alloy will tin the cast iron and make a strong bond. When arc welding with bronze rod, preheating is not generally needed. Care should be taken to avoid too high a welding current.

Other Welding Methods—Thermit welding is applied to some castings, but large areas to be filled create problems in cracking due to the high heat of the process. Forge and resistance welding are not applicable, and submerged—or hidden arc welding procedures—have not yet been developed for this type of casting.

Alloy and Controlled Irons

Ordinary gray irons such as are included in the standard ASTM specifications have a variety of properties and characteristics which make them extremely useful for an extreme range of applications. However, there are often applications in which many of the properties are wanted as-is, but some which should be modified. Therefore, alloying elements are added to achieve the desired modifications.

This section will not attempt to describe the various alloy irons, for they could well be the subject of a manual in themselves. The same could be said for the controlled irons and inoculated irons. Therefore, this discussion will confine itself to the alloying elements and additives most frequently used and the reasons for their use.

Alloying Elements

Nickel—Nickel is added to gray irons as a graphitizer. It does not form carbides. Nickel acts to reduce chill in the casting. It eliminates hard carbide spots, chilled areas and mottled areas. As a minor alloying element, nickel is used in quantities of 0.10 to 1.0%, over which range it helps refine the grain and size of graphite flakes. Nickel can supplement or replace silicon in a ratio of 2 parts of nickel for 1 of silicon. Where extremely high heat and corrosion resistance are wanted, up to 38% nickel is used.

Chromium—Small quantities of chromium added to the iron increase strength, hardness, depth of chill, and resistance to heat and wear. At the same time, however, chromium reduces machinability. Ordinarily, chromium is used in amounts of from 0.15 to 1.0%, although up to 35% is used for special heat and corrosion resistant irons. Chromium is used alone and in combination with nickel, copper, molybdenum and vanadium.

Vanadium—The element vanadium is a powerful carbide former in gray irons and acts to restrain graphitization. Usually vanadium is added to the gray iron in quantities of from 0.10 to 0.50%. The result of adding vanadium is to provide smaller flakes and a more uniform distribution of graphite. Likewise, irons containing vanadium have higher tensile strength, transverse strength and hardness, and resist decomposition at higher temperatures. In highly alloyed irons vanadium serves to improve machinability.

Molybdenum—In gray iron, the addition of molybdenum increases the depth of chill and tends to stabilize the carbides. While molybdenum helps improve properties generally, it is the most effective element to increase tensile strength and fatigue resistance. Molybdenum also aids machinability and helps in heat treating. Usually this element is added in quantities of from 0.25 to 1.25%.

Copper—Although copper is added to alloy irons in quantities of 0.25 to 2.5% normally, occasionally 3.75% is used. Copper has a slight graphitizing effect and is a mild strengthener. However, copper can either serve to harden or soften the cast iron, depending upon the base metal.

Alloy gray irons may be simple alloys with any one of the enumerated elements added. For more severe service they are usually more complex alloys. Some typical alloying combinations are: nickel-chromium - molybdenum, copper - chromium, nickel - chromium - vanadium, and nickel - molybdenum.

Controlled Irons

Most large foundries have special controlled gray irons in which they specialize. Likewise, there are proprietary gray irons, such as Meehanite, which are produced under license by several foundries throughout the country.

In a majority of cases of gray irons falling in this category, superior qualities are provided in castings by extremely careful control over melting and pouring practice. Most also include a material added to the ladle which has a profound effect upon the casting's final properties.

The materials added change the physical and mechanical properties of the iron to an extent which cannot be explained on a basis of composition.

With many "controlled," "inoculated," "treated" or "processed" gray irons, an increase in tensile strength is not always accompanied by an increase in hardness. However, these irons usually respond to heat treatments for additional hardness.

Merely adding the additional composition is not enough to assure a better casting. Control all the way through the melting and pouring is equally important.

Nodular Irons—For years it has been recognized that if the graphite in gray irons could be made to assume a nodular form in the casting, tensile and ductility properties would be enhanced considerably. Commercial attainment of such irons is now upon us. Research in the United States and England has been developed along different lines, but results are comparable.

In both countries the nodular form of graphite is attained through ladle additions. The British use cerium, while in this country magnesium has been found to serve well. Which methods will produce the better iron remains to be seen, but the development will serve to extend even further the usefulness of gray iron and its alloys.

Conclusion

It is doubtful if anyone could give even a reasonably complete list of uses of gray iron castings. They are used in the automotive industry, machine tool building, plumbing and sanitary ware, railroad equipment, electrical equipment, mining, petroleum industries, marine applications, as forming dies and rolls, power plant parts, and in almost any industry of consequence.

Gray iron castings are constantly being threatened by other materials and other fabricating methods, but despite this the number and tonnage of gray iron castings continues on the upgrade. In the past, this situation may have been true chiefly because of the cheapness and ease of castability of gray iron.

Future progress of gray iron castings will be on more firm ground, however, since past competition has spurred individual foundries and the gray iron foundry field as a whole to exercise closer control to attain better products. In addition, extensive research is going on constantly to learn why certain things are true about gray iron so that these things can be better controlled and perhaps improved.

References and acknowledgments:

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"When and How to Use Cast Iron," T. E. Eagan, MATERIALS & METHODS, Dec. 1947, p. 71

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Materials Engineering File Facts

NUMBER 174
April, 1949

MATERIALS: Steel, Aluminum, Brass
METHODS: Inspection

Measurement of Close Tolerance Parts

Considerable difficulty is experienced when measuring close tolerance parts, due to expansion and contraction of parts with temperature. This File Fact outlines a method of correcting observed micrometer readings to obtain the actual dimensions of the part at standard temperature (68 F).

Procedure

1. Three charts are included to provide corrections to be used when measuring parts made from different materials.
   Figure 1. Plain carbon and low alloy steels.
   Figure 2. Aluminum and aluminum alloys.
   Figure 3. Brass and bronze.
2. In order to apply these corrections, it is necessary to know the temperature of the part, the temperature of the micrometer, which is usually at room temperature, and the approximate dimension to be measured.
3. The temperature of the part is first located on the horizontal scale, the temperature of the micrometer is located on the vertical scale, and the point or intersection of these two temperatures is located.
4. The diagonal line closest to this point is the correction to be applied for each inch being measured.
5. This correction is multiplied by the number of inches being measured to obtain the total correction.
   a. If the correction is positive (+), the correct micrometer setting is obtained by adding the total correction to the required dimension.

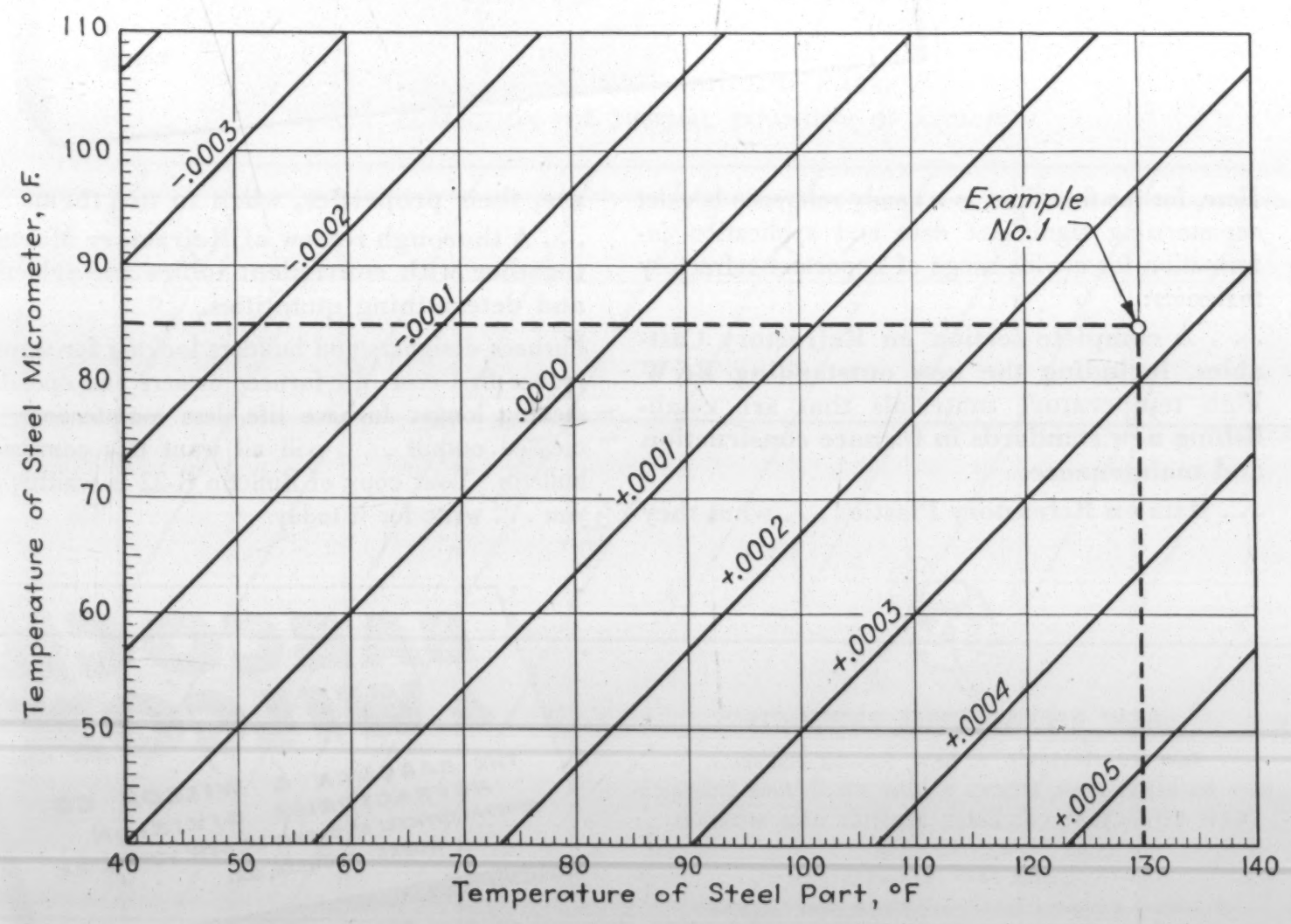
Example I

Steel part at 130 F	
Micrometer, temperature 85 F	
Required dimension (basic)	2.0000
Correction per in. (from Fig. 1) +0.00027 (est.)	
Total correction: 0.00027 × 2.00 =	0.00054
Micrometer setting	2.00054

Example II

Aluminum part at 110 F	
Micrometer, temperature 70 F	
Required dimension	2.6275
Correction per in. (from Fig. 2) +0.00052 (estimated)	
Total correction: +0.00052 × 2.6 =	+.00136
Set micrometer at	2.6289

FIG. 1—CORRECTION FOR THERMAL EXPANSION OF STEEL



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(Continued on page 81)

What to use... Where to use it!

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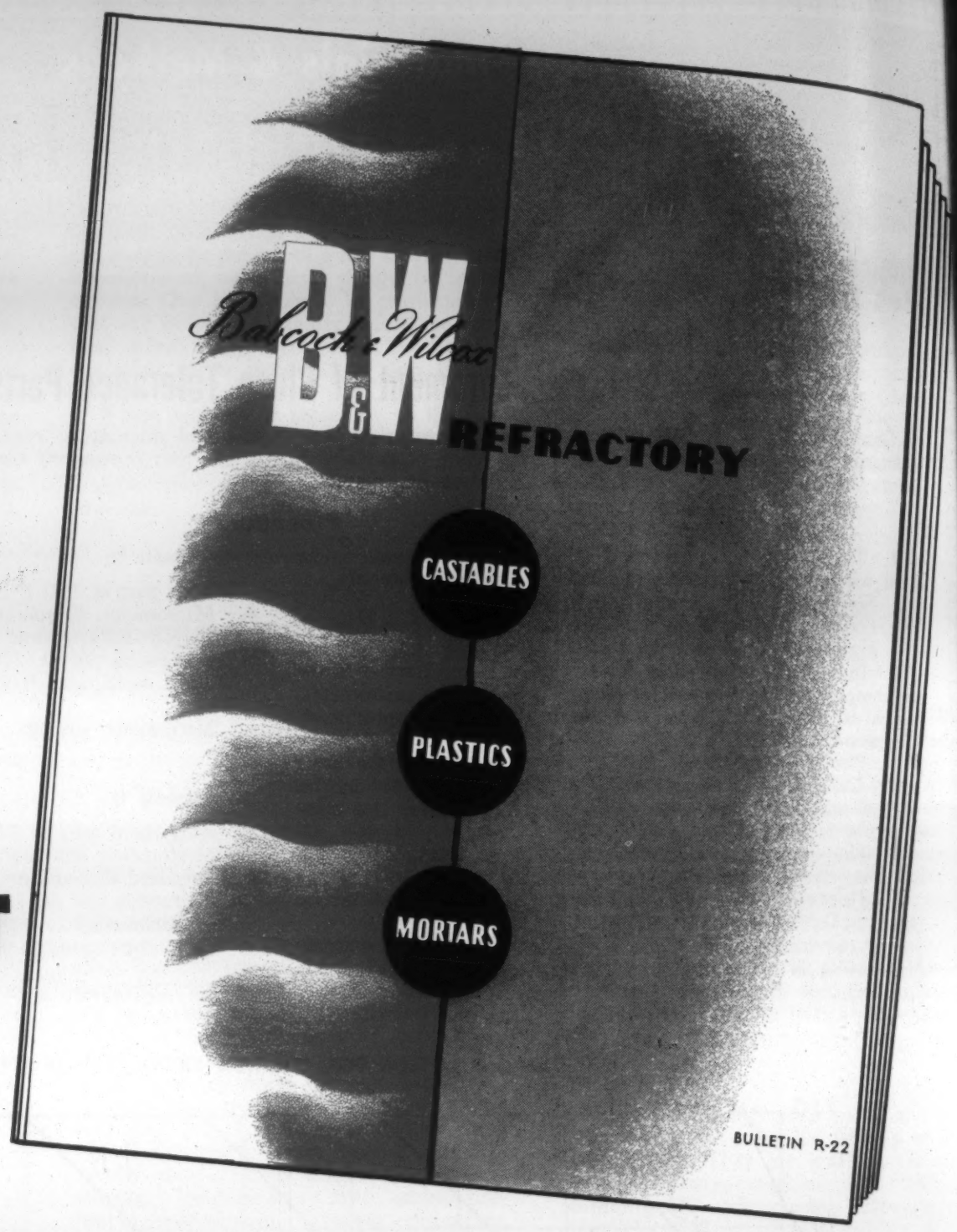

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Materials Engineering File Facts

NUMBER 174 (Continued)

MEASUREMENT OF CLOSE TOLERANCE PARTS

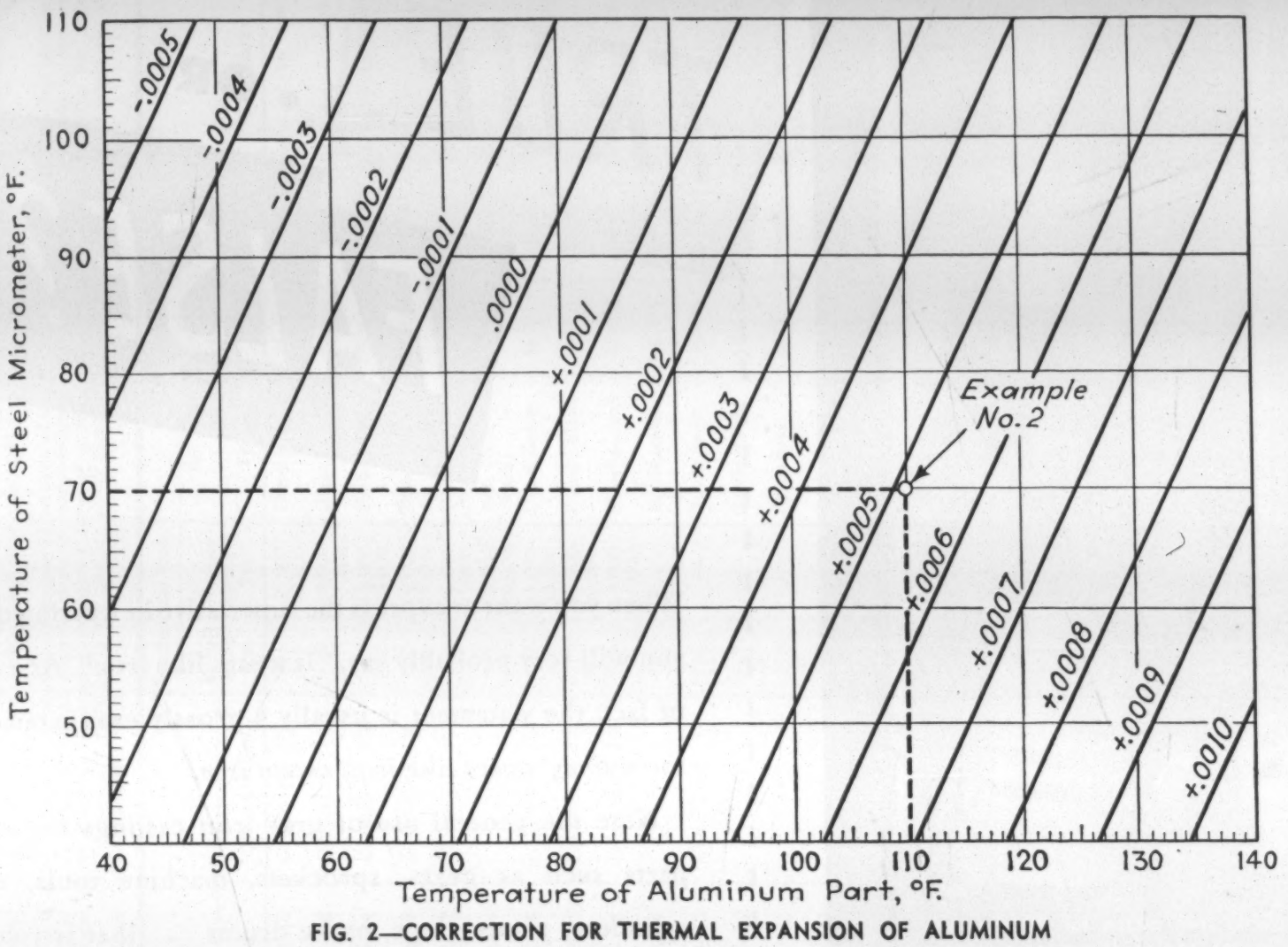

FIG. 2—CORRECTION FOR THERMAL EXPANSION OF ALUMINUM

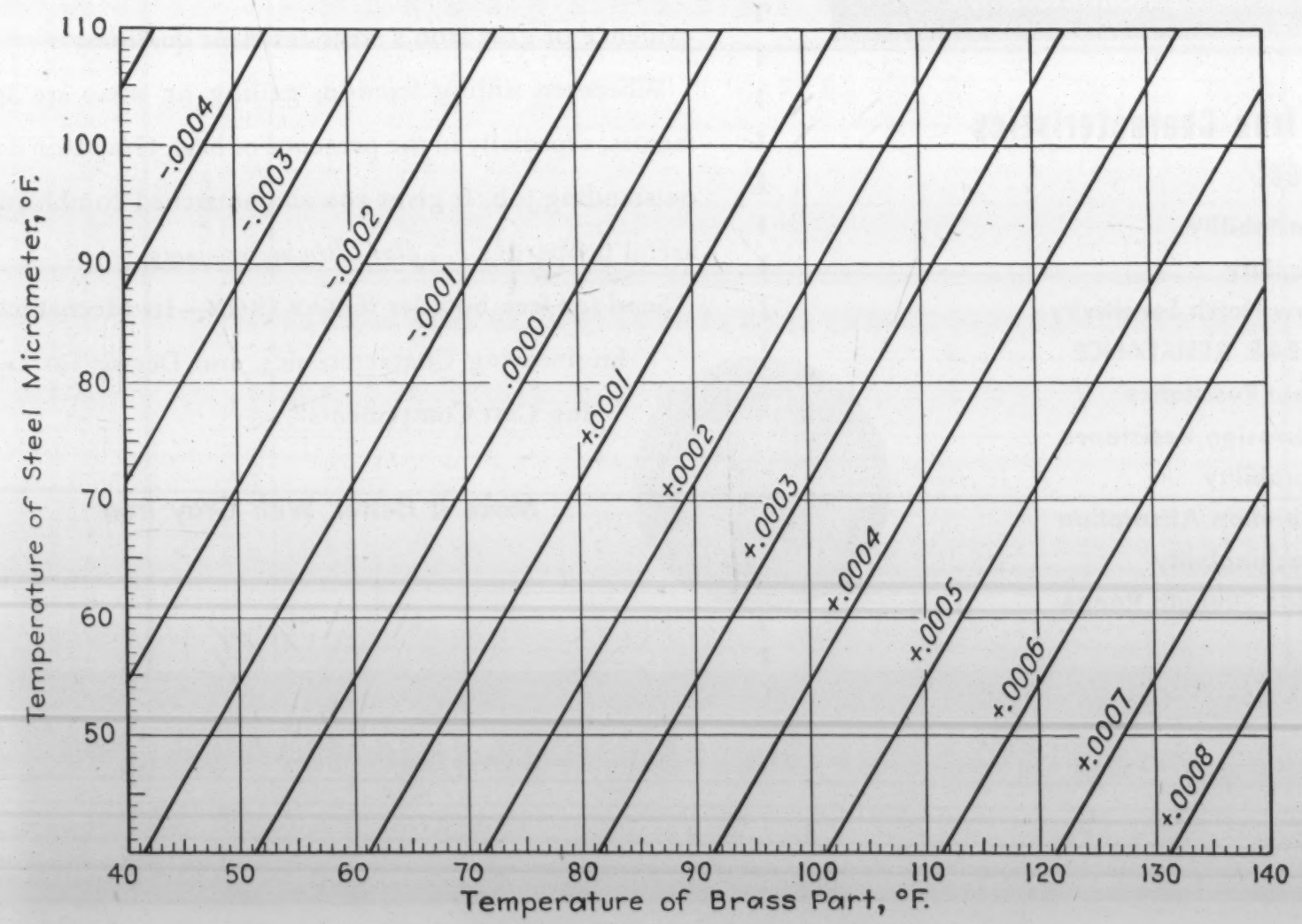

FIG. 3—CORRECTION FOR THERMAL EXPANSION OF BRASS

Gray Iron piston for 800-horse-power, engine-driven compressor.

Gray Iron Characteristics Include:

Castability
Rigidity
Low Notch Sensitivity
WEAR RESISTANCE
Heat Resistance
Corrosion Resistance
Durability
Vibration Absorption
Machinability
Wide Strength Range

"it wears like iron"...

TRUE... OR FALSE?

When you want to express the superlative in wearing quality, you will very probably say, "It wears like iron!" As a matter of fact, the statement is usually a grossly exaggerated one, for *nothing* wears like iron *except iron.*

Note the general use of gray iron castings for moving parts such as gears, sprockets, machine tools, engine cylinders, piston rings, brake drums . . . that is your best evidence of gray iron's wear-resistant qualities.

Wherever sliding friction, galling or wear are serious factors, especially in the presence of heat, Gray Iron does an outstanding job. It gives you an unmatched combination of useful properties . . . *plus ultimate economy.*

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Vanadium Alloyed Irons

An iron that can withstand the drastic temperature changes met in many modern types of equipment is in growing demand in industry. A technique of alloying such irons has been developed by Vanadium Corp. of America.

The types of iron and the alloying procedure that produces them are not new, having been used in severe service applications for a number of years. However, application to a wider variety of work has had to await a study of service experience with many castings subjected to rapid changes of temperature.

The objective is the production of an iron of adequate strength but with the lowest modulus of elasticity compatible with the strength level prescribed. Experimentally, it has been demonstrated that the high total carbon irons have relatively high deflection, which automatically tends to lower elastic modulus for a given strength value.

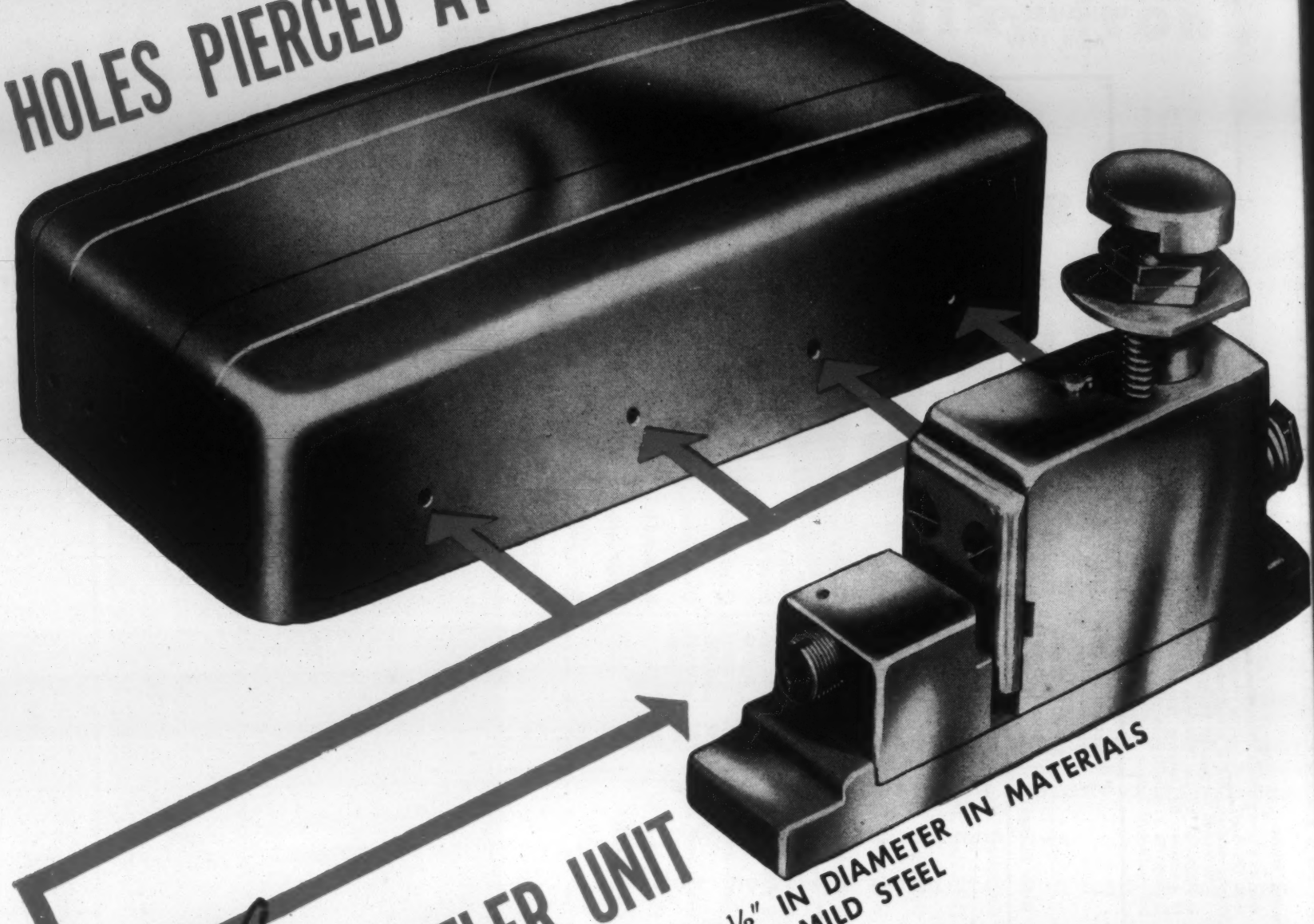
Strength is secured by proper adjustment of silicon to yield a pearlitic matrix, and this matrix is improved by the alloying elements, molybdenum and vanadium. Vanadium assists in the control of hardness by keeping the matrix lamellar in character. It also adds materially to the strength. It imparts a stability to the pearlite which prevents decomposition at temperature levels too severe for unalloyed irons.

Item No.	Designation	Analysis										Mechanical Prop.		Uses			Remarks
		T.C.	Si	P (Max.)	S (Max.)	Mn	Ni	Cr	Mo	V	Other Elements	Brinell Hardness	Tensile Strength Psi.	Type	Metal Section Range In.	Weight Range Lb.	
1	Mo-V	3.55-3.75	1.40-1.60	.15	.10	.60-.80	—	—	.40-.70	.08-.12	Graphidox[a] .1%	201-241	35,000-40,000	Diesel heads	¼-¾	50-300	Resistant to heat shock
2	Mo-V	3.55-3.75	1.70-2.10	.15	.10	.60-.80	—	—	.30-.60	.08-.12	Graphidox[a] .1%	179-217	30,000-35,000	Glass molds	⅜-1¼	30-150	Resistant to heat shock if cast in modified chill
3	Mo-V	3.55-3.75	1.25-1.50	.15	.10	.60-.80	—	—	.40-.70	.10-.14	Graphidox[a] .1%	197-235	40,000-50,000	Brake drums	½-1¼	40-150	Resistant to heat cracks
4	Ni-Cr-Mo-V	3.50-3.70	1.25-1.50	.15	.10	.60-.80	1.25-1.75	.30-.40	.30-.50	.08-.12	Graphidox[a] .1%	207-248	40,000-50,000	Brake drums	½-1¼	40-150	Resistant to heat cracks
5	Mo-V	3.50-3.70	1.60-2.00	.15	.10	.60-.80	—	—	.30-.50	.08-.12	Graphidox[a] .1%	197-235	35,000-45,000	Clutch plates	½-1¼	10-40	Resistant to heat cracks
6	Cr-Mo-V	3.40-3.60	.75-1.25	.20	.12	.60-.80	—	.25-.40	.40-.60	.10-.14	—	197-235	35,000-40,000	Dies (cold work)	2 up	4000-40,000	Wear resistant
7	Cr-Mo-V	3.45-3.65	1.30-1.70	.15	.10	.60-.80	—	.25-.40	.40-.70	.10-.14	Graphidox[a] .1%	197-248	35,000-40,000	Diesel sleeves	¾-2	70-300	Wear resistant and induction hardenable
8	Ni-Mo-V	3.40-3.60	1.35-1.60	.15	.10	.60-.80	.75-1.25	—	.60-.80	.10-.15	Graphidox[a] .2%	217-269	45,000-60,000	Diesel pistons	½-1½	30-150	High strength; resistant to heat and wear
9	Ni-Cr-Mo-V	3.15-3.35	1.60-1.90	.15	.10	.60-.80	.75-1.25	.30-.50	.60-.80	.12-.18	Graphidox[a] .2%	235-269	50,000-65,000	Diesel pistons	½-1½	30-150	High strength; wear resistant
10	V	3.60-3.75	2.10-2.30	.20	.10	.60-.80	—	—	—	.12-.15	—	187-217	—	Bottle molds	½-1½	5-45	Resistant to heat checks; good stability
11	V	3.60-3.80	2.00-2.20	.20	.10	.60-.80	—	—	—	.10-.12	Cu .75-1.00	196-227	—	Bottle molds	½-1½	5-45	Resistant to heat checks; good stability
12	Mo-V	3.60-3.80	1.90-2.10	.20	.10	.60-.80	—	—	.35-.50	.08-.12	—	187-227	—	Bottle molds	½-1½	5-70	Resistant to heat checks; good stability
13	Mo-V	3.60-3.80	1.50-1.70	.30	.12	.60-.80	—	—	.30-.50	.08-.12	—	179-207	—	Grate bars	½-2	10-150	Resistant to heat checks; good stability
14	Mo-V	3.35-3.55	1.60-1.90	.20	.10	.60-.80	—	—	.40-.60	.10-.12	—	196-235	40,000[e]	Brake drums	½-1½	50-200	Strength with heat-shock resistance
15	V	3.60-3.85	2.40-2.70	.40-.60	.12	.60-.80	—	—	—	.15-.25	—	—	—	Piston rings (automobile)	⅛-¾	.05-.25	Stability of tension
16	Cr-V	3.45-3.65	.80-1.10	.25	.10	.50-.70	—	.40	—	20	—	—	—	Chilled rolls	—	—	—
17	Mo-V	3.25-3.40	1.70-2.00	.25	.11	.60-.80	—	—	.30-.50	.12-.15	—	196-235	40,000[d]	Machine tools	½-2½	100-3000	Wear resistance and hardness
18	V	3.25-3.40	1.60-1.90	.25	.11	.70-.90	—	—	—	.12-.15	Cu .75-1.00	187-217	38,000[e]	Machine tools	½-2½	100-3000	Minimum section sensitivity
19	Cr-V	3.30-3.45	2.00-2.20	.20	.10	.60-.80	—	.30 as V-5[g]	—	.08-.10	—	187-217	35,000[f]	Elevator sheaves	¾-3	15-300	Exceptional soundness
20	Mo-V	3.40-3.65	2.20-2.40	.25	.10	.60-.80	—	—	.30-.40	.07-.10	—	211-248	—	Exhaust manifolds	⅛-½	5-25	Resistant to heat shock and growth
21	Cr-V	3.20-3.40	1.40-1.80	.20	.10	.65-.80	—	.30 as V-5[g]	—	.12-.15	—	207-241	40,000[d]	Pressure castings	½-1½	40-1000	Soundness and uniformity of structure
22	V	3.35-3.55	1.40-1.65	.25	.12	.50-.70	—	—	—	.12-.15	—	187-207	—	Aluminum melting pots	¾-2½	150-600	Resistant to heat shock
23	Mo-V	3.35-3.55	1.00-1.60[b]	.12	.12	.60-.90	—	—	.40-.60	.08-.15	—	197-241	—	Dies (cold work)	1-6	—	Suitable for flame hardening
24	Ni-Cr-Mo-V	3.20-3.50	1.00-2.00[b]	.12	.12	.60-.90	1.25-1.75	.40-.60	.40-.60	.08-.15 (optional)	—	207-255	—	Dies (cold work)	3-12	—	Suitable for flame hardening

[a]—*Addition—0.1% equals 2 lb. per ton; .2% equals 4 lb. per ton*
[b]—*To be adjusted to give specific hardness on critical surfaces*
[c]—*Load, lb.—3000; defl., in.—.28*
[d]—*Load, lb.—3000; defl., in.—.30*
[e]—*Load, lb.—2900; defl., in.—.30*
[f]—*Load, lb.—2800; defl., in.—.28*
[g]—*V-5 Foundry Alloy*

Prepared for publication in MATERIALS & METHODS *by Vanadium Corporation of America, 420 Lexington Ave., New York 17, N. Y.*

HOLES PIERCED AT 90° ANGLE...



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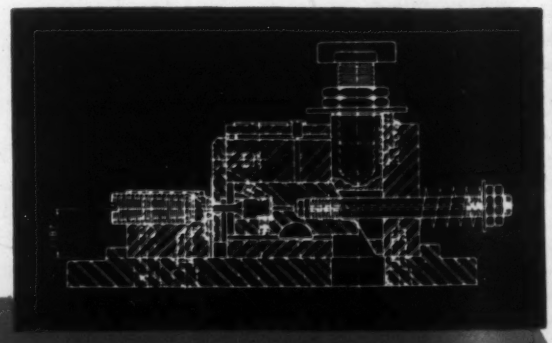
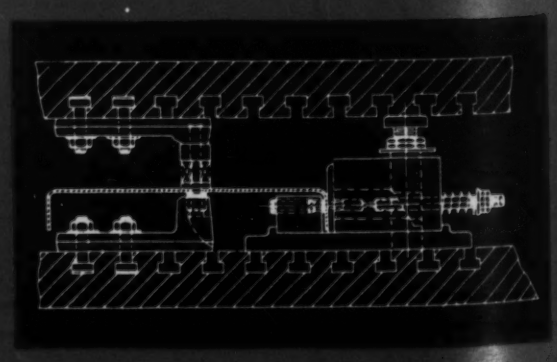
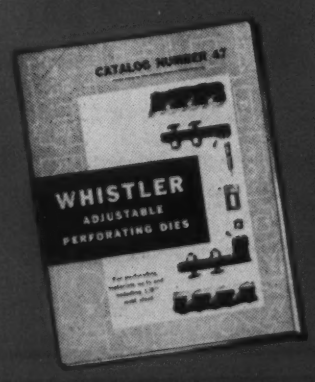


Detailed drawing showing operation of HU-50 90° Perforating Unit.



Typical set-up shows 90° perforating unit operated in conjunction with standard perforating equipment.



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MATERIALS & METHODS

DIGEST

A selective condensation of articles—presenting new developments and ideas in materials and their processing—from foreign journals and domestic publications of specialized circulation.

Edited by H. R. CLAUSER

Nodular Cast Iron Now Being Produced in This Country

Nodular graphite cast irons, which show substantial improvement in strength, ductility and toughness over conventional irons, are now available to American industry. Original research, carried out by the British Cast Iron Research Association, has been reported during the past few years in England. And in the past several months, developments in this country have been published.

C. K. Donoho, in the *American Foundryman,* Feb. 1949, discusses the work done by the *American Cast Iron Pipe Co.,* involving the use of magnesium alloys as the agent for producing the nodular graphite structure. The British have used cerium additions to accomplish the same result. The advantages of magnesium treatment over cerium are that magnesium is effective in low carbon, high phosphorus, and relatively high sulfur irons. In addition, the cost of cerium is higher and magnesium treatment appears to be effective in a much wider range of iron compositions. The disadvantage of using magnesium is the difficulty and hazard of making the addition.

Information on the work done on nodular cast iron by the *International Nickel Co., Inc.,* involving the use of a nickel-magnesium alloy, has also been released recently. The material is characterized by a graphite structure in the form of spheroids, free from graphite in the flake form. For pearlitic grades of cupola-melted material containing 3.2 to 3.6% carbon and 1.8 to 2.8% silicon, the ductile iron provides, in the as-cast condition, a combination of 85 to 105,000 psi. tensile strength, with some ductility. Under stress it behaves elastically like cast steel rather than cast iron.

The potential applications for this new material are many. The automotive, agricultural implement and railroad industries could apply it, both as-cast and heat treated. Machinery in general could utilize its high strength and rigidity. Its ductility may provide thermal shock resistance far greater than has been available in high carbon castings. The high resistance to growth and oxidation gives promise of its use in many engine, furnace and other parts used at elevated temperatures. Other products include pipe, textile machinery, electrical machinery and marine equipment. However, much development work remains to be done on methods of production, alloying, heat treatments, and special properties of the material.

Impact Extrusion Developments

Preliminary results of a study by R. Hanes on some of the factors involved in impact extrusion appeared in the Jan. 1949 issue of *Sheet Metal Industries* (British).

The determination of the metal flow is described in detail as it is important in the extrusion of complicated shapes. Some attention is also given to load measurement, as it is valuable in determining the suitability of a press, designing tools and determining the maximum slenderness of indirect punches. Under the conditions investigated, variations in the shape and surface finish of the tools and in the quantity of lubricant had no significant effect on the extrusion loads. There was no quantitative correlation between the impact loads and tensile strength.

The results indicated the magnitude of the loads involved. For example, with an aluminum alloy and a reduction of 85% in impact extrusion, the ratio between the impact and deep drawing loads was over 20 to 1, while the ratio increased to 80 to 1 for a reduction of 95%.

Commercially, the main advantage of impact extrusion lies in the production of a simple shape in a single operation instead of a number of operations, as in deep drawing. There is also a saving in the number of presses and tools, but impact extrusion presses must be much stronger than drawing presses. There are three types of impact extrusion: indirect, where the material moves up around the punch to form a solid-based tubular product; direct, where the metal flows in the same direction as the punch movement; and Hooker tubing for open ended tubular products, where the flange is separated from the tube in the extrusion die by a clipping punch.

The high reductions in impact extrusion are possible only because of the deformability of the metal. Aluminum and zinc are most widely used. Metals which work harden rapidly, such as austenitic stainless steel, cannot be impact extruded at room temperature. At the other extreme, lead and tin, which show negligible work hardening and do not lend themselves to deep drawing, can be impact extruded with ease.

With copper and heat-treatable aluminum alloys, the limit to the reduction is set not by their capacity for deformation but by the strength of the tool. Metals other than lead and tin work harden during extrusion so that the extrusions are rigid and hard.

● Five important requisites of material specifications are discussed in an informative article by L. S. Reid and W. R. Willets in the *ASTM Bulletin,* Jan. 1949. The requisites are: (1) accuracy and precision, (2) workability, (3) suitability, (4) flexibility, and (5) acceptability.

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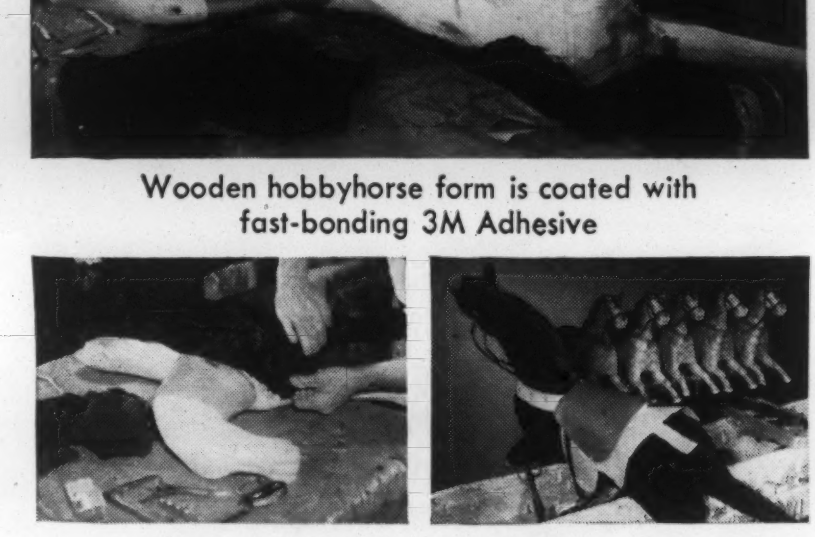

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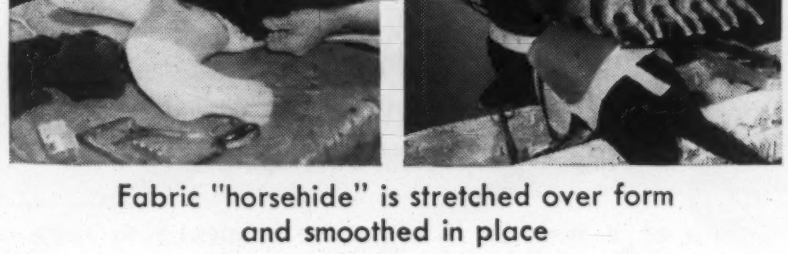

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DIGEST

Advantages of Hot Extruded Steel Parts

The many advantages of hot extrusion methods were illustrated by C. L. Stevens and G. Vannerholn in a paper presented before the *Society of Automotive Engineers*. The process is being used successfully on passenger car front wheel spindles as well as other parts.

Extrusion forging differs from conventional forging in that a punch and die are made in such a manner that the heated metal is confined so that it can only flow into the shape desired. Extruded forgings have very desirable fiber direction because the pressure of the press causes the correct volume of heated steel to flow or extrude into the die cavities.

In adopting the extrusion method for producing wheel spindles, a number of savings were realized. There was a saving of approximately 10 tons of steel per day that would otherwise be discarded as scrap in the form of flash. The upset and forge method required 46 men, compared to 16 men required for the extrusion method. In addition, there were savings in floor space and the amount of equipment required.

The properties of the spindles was also improved. There was an increase in strength for equal sections resulting from a near approach to ideal fiber flow conditions. And average fatigue life of the extruded spindle exceeded that of the forged part by 17.3%.

Use of Cast Steel and Welding in Composite Parts

The benefits obtained by the use of welding to produce complicated parts have been gradually recognized. The problem of the use of castings in such parts is discussed by H. Gerbeaux in the Oct. 1948 issue of *Fonderie* (French), with numerous illustrations from American as well as French practice.

Welding has long been used for repairing defective castings, but its acceptance for the production of composite parts from simple castings is still questioned by some in France. The solution to this prejudice is believed to be: (1) the introduction of readily available, standard cast components, and (2) the guarantee by the foundries that the castings are weldable and of high quality. Production welding requires more consideration of weldability than does the

DIGEST

repairing of castings by welding. In the latter case, more precautions can be taken to avoid cracking, while in the former case, the castings must be suitable for rapid and economic welding. If the welded part is not annealed after welding, even more care is needed.

Many of the difficulties involved in the casting of complex parts of steel disappear if the part is broken down into a number of simple components to be assembled by welding. Moreover, many types of inspection, such as X-ray, supersonic and magnetic methods, may be applied to simple castings much more readily than to complex ones. Sometimes, the final machining can be simplified by preliminary machining operations on the components before assembly.

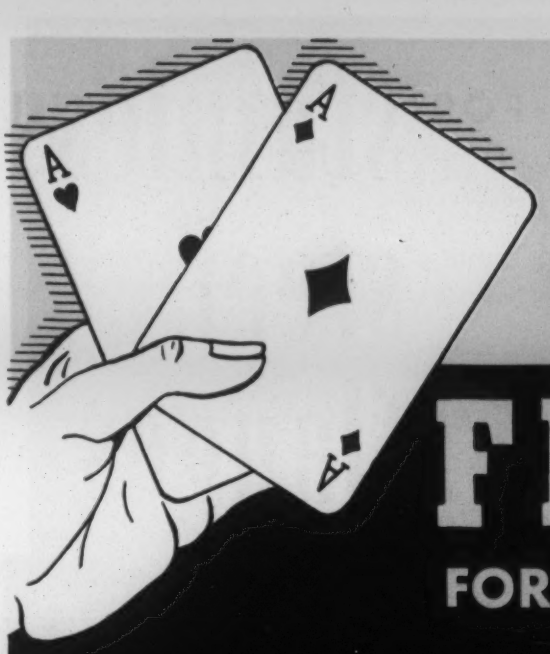
In view of the proved advantages of assembled parts containing castings, foundries should adopt welding for other purposes than simple repairs, and welding shops should adopt castings for use in composite parts. In France, where most production is on a relatively modest scale, cast steel is often economically more advantageous than wrought steel. It will be necessary, however, to standardize and stock the essential cast components.

Recent British Advances in Magnesium

In the future it may be no more difficult to process magnesium than aluminum, according to an article in *Light Metals* (British), Jan. 1949. The usual magnesium alloys have demonstrated their value for normal engineering conditions but are generally weak at elevated temperatures. Moreover, special fluxes and inhibitors are needed during melting and heat treatment to prevent oxidation.

The alloying elements that appear promising for better magnesium alloys are cerium, beryllium and zirconium. Small additions of cerium markedly increase the hardness at 570 F. The excessive oxidation losses of cerium are minimized by calcium. Beryllium, in amounts from 0.005 to 0.10%, enables magnesium alloys to be melted and cast without protective fluxes or atmospheres. Small zirconium additions reduce the grain size of pure magnesium or magnesium-zinc alloys and, therefore, give good mechanical properties.

Difficulties were originally encountered in the commercial production of these alloys because of the loss of zirconium during melting. This has now been remedied by the



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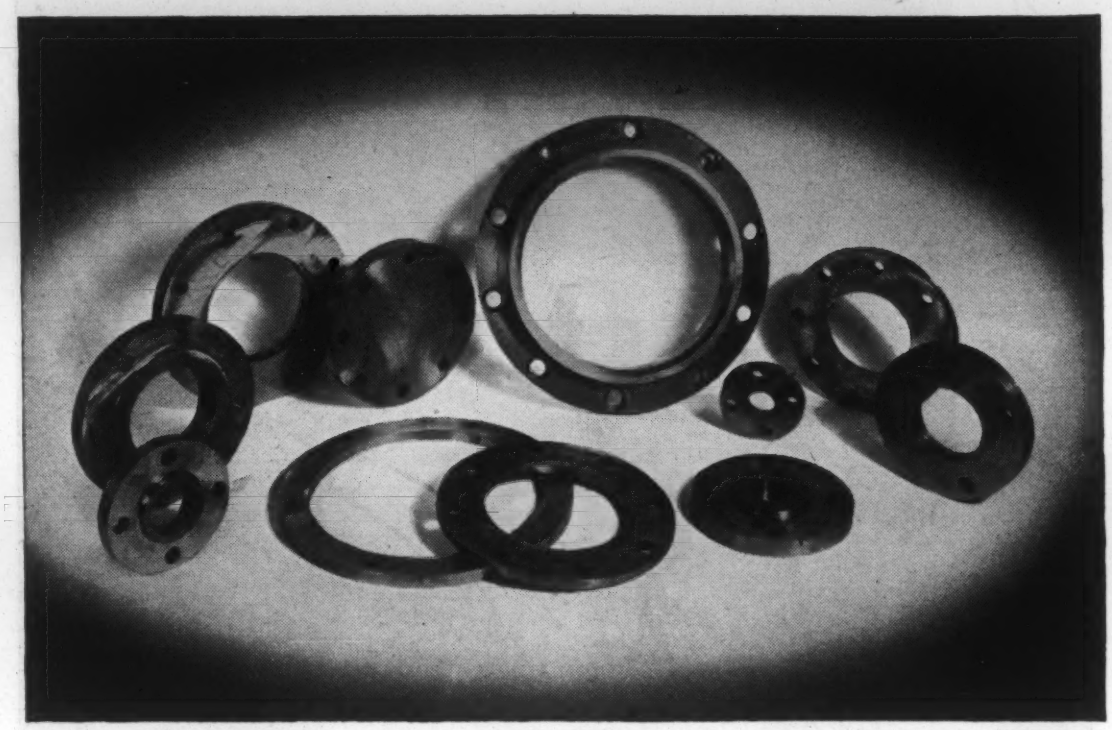

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use of a master zirconium salt. Great care has to be used to maintain the purity of the magnesium-zirconium alloys, as their properties are adversely affected by trace impurities. Their corrosion resistance is high and compares favorably with that of the super-purity alloys.

A recent patent (British Patent No. 603,150) on a magnesium alloy with cerium, beryllium and zirconium appears to represent a distinct advance. The loss during melting of cerium and zirconium, due to the reaction with the flux, is overcome by the beryllium, which eliminates the use of fluxes. The zirconium and beryllium are added in the form of a silver prealloy with about 2 silver, 0.75 zirconium and 0.5% beryllium. The silver does not affect the grain refinement conferred by the zirconium and is advantageous for alloys to be used at high temperatures. The cerium can be added as mischmetal or a magnesium-cerium alloy.

Magnesium-Lithium-Base Alloys with Improved Properties

While the usefulness of commercial magnesium-base alloys has been amply demonstrated, even wider applications could result from improvements in cold rollability and cold-forming characteristics. In the *Journal of Metals*, Feb. 1949, J. H. Jackson, P. D. Frost, A. C. Loonam, L. W. Eastwood and C. H. Lorig report that by an addition of about 10.3% by weight or more of lithium such improvements along with production of less directionality in properties can be realized.

The melting of magnesium-lithium alloys is no more difficult than the melting of ordinary magnesium, provided certain precautions are followed. The alloys can be hot worked with ease of temperatures around 450 F. In cold rolling, total reductions of 50% are common for most compositions. While many of the magnesium-lithium-base alloys can be cold drawn, some difficulty is encountered when starting the cold-drawing operation because the alloys do not work harden well and tips formed on the ends of bars are not sufficiently strengthened to withstand the stresses necessary to start the bar through the die.

The alloys have good mechanical properties; hardness runs around 85 Brinell. Since yield strengths are approximately 40,000 to 45,000 psi., they compare favorably on a strength-weight basis with the strongest available commercial aluminum-base alloy, 75ST. The modulus of elasticity averages

about 6,500,000 psi., is the same in tension and compression, and compares favorably with that for the commercial magnesium-base alloys.

The corrosion resistance of most magnesium-lithium-base alloys, especially those containing large quantities of zinc, silver, and/or cadmium is poor. However, the alloy containing 11% lithium had good corrosion resistance and can be used to clad and to protect anodically many of the higher strength alloys.

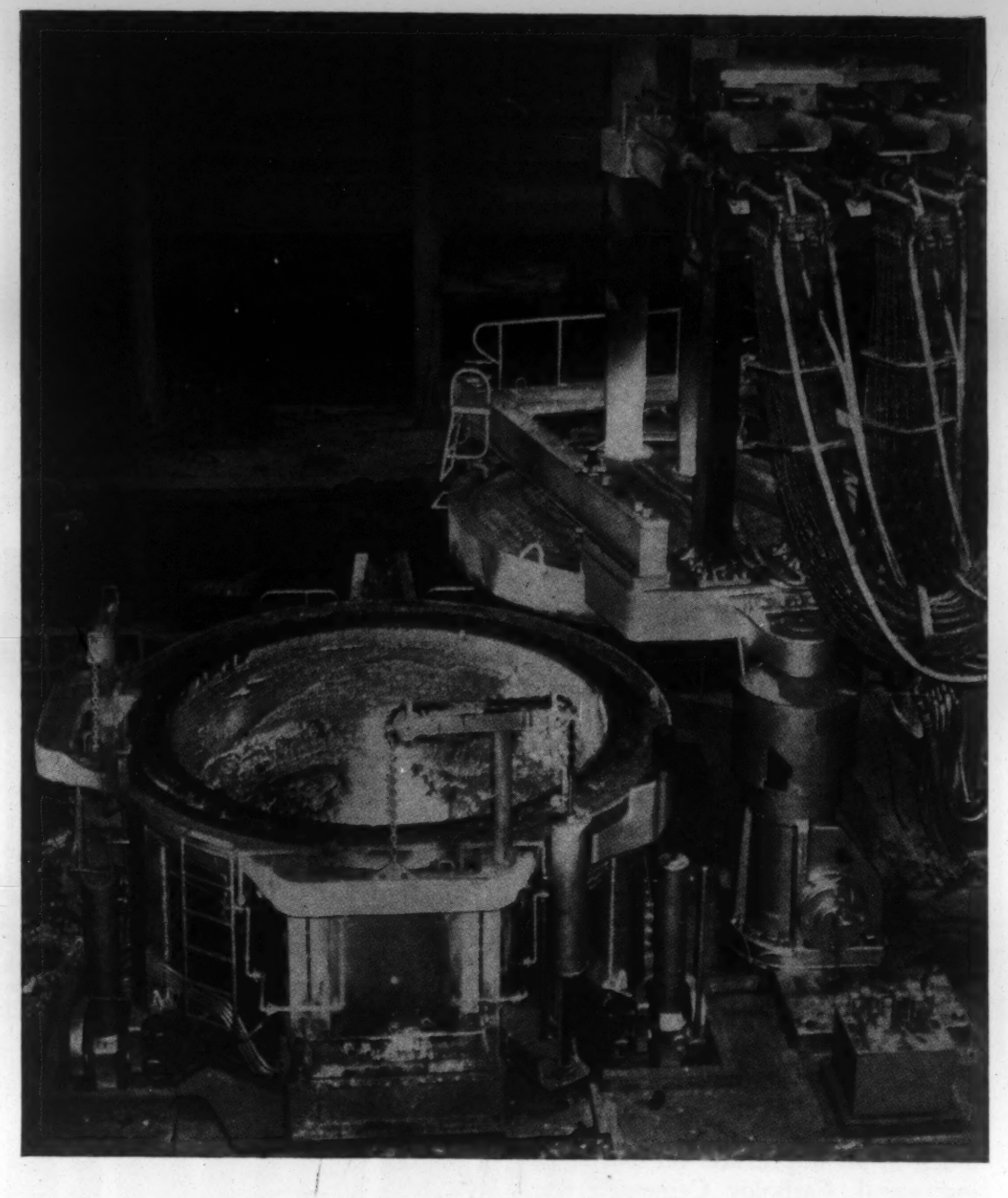
● The steel molds formerly used by the Garlock Packing Co. in the manufacturing of rubber composition packing wore out inordinately fast and resulted in excessively high production costs. *Morley Machine Corp.* and *Air Reduction Sales Co.*, working in conjunction, devised a special oxyacetylene flame hardening installation to combat this problem. Two revolving adjustable speed table setups were used to accommodate symmetrical and circular steel surfaces up to 24 and 64 in. in dia. On these, flame hardening torches were mounted for hardening the molds. The depth of flame hardening was controlled to about 1/16 in. on the lips and faces of each set of molds. This treatment resulted in increased mold wearability and improved packing quality.

Rod Stock Produced from Light Metal Turnings

A unique method of using aluminum and magnesium turnings has been proposed by the Germans, and some preliminary experiments, reported by F. Sauerwald in *Archiv für Metallkunde* (German), are briefed in *Metal Industry* (British), Dec. 3, 1948.

"Sawdust" of an aluminum-9% magnesium alloy and a magnesium-9% aluminum alloy was pressed into briquettes, which were sintered in an argon atmosphere. Some of the sintered briquettes were subsequently extruded into rod. These extruded sections had about the same strength as extrusions made from cast metal.

Further tests were made with the same technique to explore the possibilities of preparing light alloys beyond the ranges of the usual commercial alloys. The formation of brittle intermetallic phases in aluminum-magnesium, magnesium-aluminum and aluminum-copper-magnesium al-



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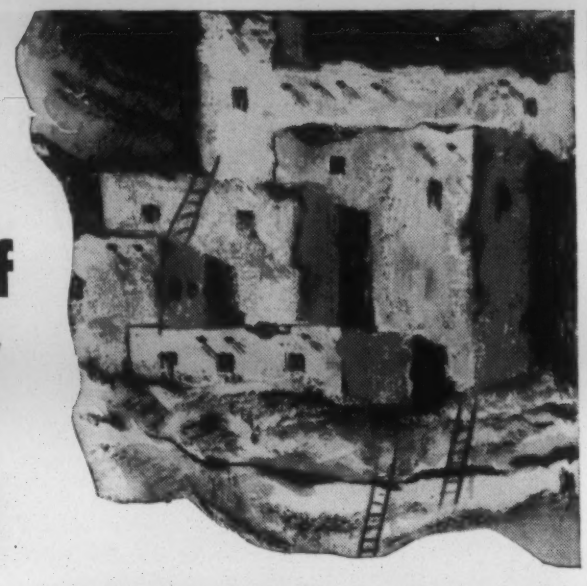

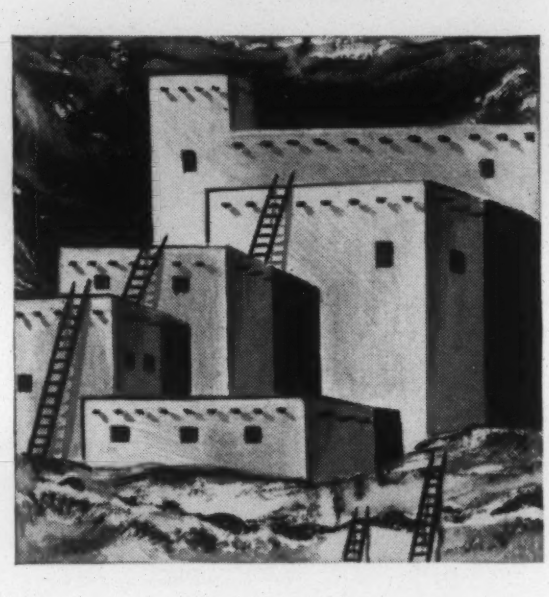

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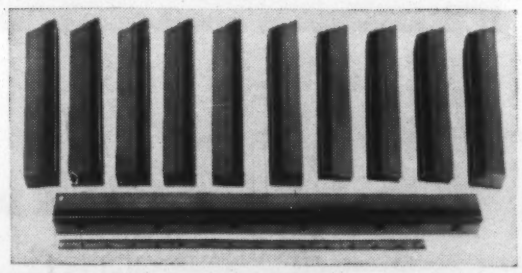
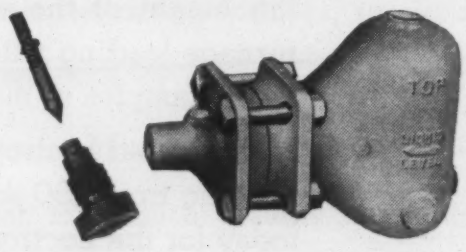
Wherever wear is causing costly downtime, too-frequent replacements, poor finishes, or too many rejects, use a wearproof part made of Carboloy Cemented Carbide.

Don't wait. Every day, wear may be costing you more than the cost of a change-over to Carboloy Cemented Carbides! Call in a Carboloy engineer at the first sign of wear anywhere.



Manufacturers of metal desks, cabinets, chairs, and boxes shape sheet-metal parts with Carboloy-tipped bending bars. They get scratch-free results and longer service from Carboloy Cemented Carbides.



Refrigeration manufacturers find that these Carboloy inserts for refrigerator regulating valves last up to 6 times longer than steel parts, resist wear and corrosion of ammonia.

CARBOLOY COMPANY, INC.
11161 E. 8 Mile Street, Detroit 32, Michigan

WHEREVER THERE'S MOTION THERE need not be ~~is~~ WEAR

WEAR PROOF with CARBOLOY® CEMENTED CARBIDE HARD METAL

DIGEST

loys could be prevented to a large extent by limited heating. Nevertheless, the mechanical properties of the sintered briquettes and the sections extruded from them were disappointing.

Another idea which was investigated was the use of powder metallurgy to process magnesium crystals obtained by distillation. It was thought that it might be possible in this way to avoid contamination of the metal during melting. The corrosion resistance of the sintered and extruded magnesium was, in fact, superior to that of cast magnesium.

Low Alloy Steels with Titanium for Heat Resistant Parts

The interest in titanium has not been confined to its prospects in titanium-base alloys but has also extended to its use as an alloying element in steel. G. Delbart, R. Potaszkin and A. Kohn investigated its effect in relatively low alloy steels with the hope of increasing the maximum temperature at which nonaustenitic steels can be used. The results are given in the Oct. 1948 issue of *Revue de Métallurgie* (French).

The four steels studied were:

No.	%C	%Si	%Cr	%Ti	%Al	%Mo
1	0.14	0.78	3.20	0.6	0.09	—
2	0.12	2.20	3.15	0.7	0.07	—
3	0.18	1.80	5.15	0.6	0.40	—
4	0.25	0.56	1.60	0.3	0.07	0.42

The short time creep strength (35-hr. tests at 1040 F) was markedly affected by the prior heat treatment, even when the room temperature properties were unchanged. The higher austenitizing temperatures produced higher creep strengths, while the optimum tempering temperature varied with the composition and the austenitizing temperature.

The choice of the best heat treatment, however, must also take into account the room temperature properties. The high silicon steels had low impact strengths at room temperature in all conditions. Steel No. 1 appeared to be susceptible to temper brittleness, as its impact strength was lowered by holding at 1020 to 1200 F, or slow cooling through this range. The hardness and impact strength of the chromium-molybdenum steel were very sensitive to prior treatment as air cooling produced considerable grain boundary ferrite.

The most interesting steel appeared to be the pearlitic chromium-silicon steel, No. 1. The ferritic chromium-silicon steel (No. 2)

DIGEST

had good creep strength and, in some cases, even a negative creep rate, probably caused by structural changes during the test. The semi-ferritic chromium-silicon steel (No. 3) and the pearlitic chromium-molybdenum steel (No. 4) had higher creep rates. It was pointed out, however, that the titanium content of the latter steel was very low and the titanium to carbon ratio was only 1.2.

Alloy Steels for Powder Metallurgy

The progress that has been made in the production of sintered alloy steels in England is reviewed by H. W. Greenwood in the Jan. 1949 issue of *Iron and Steel* (British).

Some of the first work was done on stainless steels, where attempts were made to use pre-alloyed powder as well as mixed powders. Neither proved economically successful, for the former had poor pressing qualities while the latter required extreme sintering conditions to obtain adequate diffusion. Even with the lower alloyed 2330 steel, it was found that excessive sintering times were needed to give complete diffusion.

In Great Britain, the best results have been obtained with an alloy steel containing 2 to 8 nickel, 0.2 to 1.4 manganese, and 0.08 to 1% graphite. The sintered product with 10% porosity has a tensile strength of about 63,000 psi., with an elongation of 8%. This composition can be hardened by cyanide or pack carburizing to produce a file hard surface. Among the products being mass produced today in this material are rifle magazine catches, hub gears, pawls, chain bushes, ball bearing races and die shoes for tangential die heads. In the latter case, equal service life is obtained with a saving of around 60% in the original cost.

When proper care is taken to ensure homogeneity, sintered alloy steels have higher tensile strength than standard steels of the same composition. Homogeneity is the controlling factor in the production of any alloy that must have high physical properties. More attention should be paid to hot pressing, which is a great aid in the attainment of homogeneity. The presence of a small amount of a liquid phase during sintering is likewise of great importance.

It is not too much to hope that an extended use of hot pressing combined with a small percentage of a liquid phase may result in the production of a wide range of sintered alloy steels and a solution to the problem of alloys capable of withstanding high temperatures and stresses.

PROBLEM: Provide a seal for turbines that will hold high pressure live steam...resist corrosive forces...function without conventional lubrication.

SOLUTION: Morganite Carbon Seals —self-lubricating qualities resist temperature extremes . . . nullify the factor of inaccessibility...are immune to corrosion... prevent scoring and wear.

MORGANITE

SELF-LUBRICATING, HIGH PRESSURE

SEALS, RINGS and WASHERS

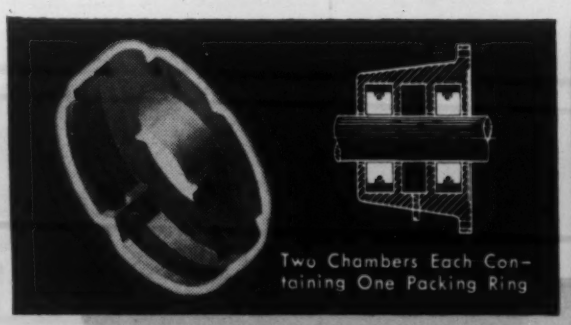
The successful application of self-lubricating seals in high pressure lines is another example of the basic advantage of Morganite Dry Lubrication — an inherent lubrication that equals the life of the seal without renewal. Full retention of steam, from cold start to full-load high temperatures, is assured. Surface scoring, which opens the way for rapid surface erosion by live steam, is eliminated.

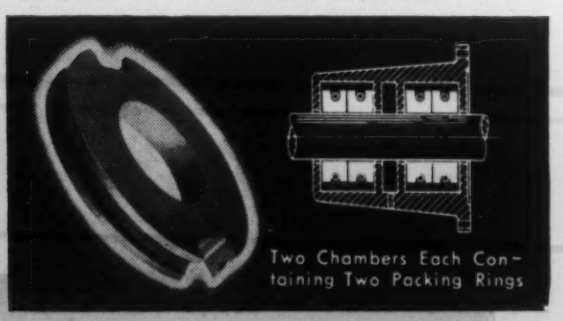
see our CATALOG in SWEET'S FILE for PRODUCT DESIGNERS

For detailed information consult the Morganite Catalog in Sweets File for Product Designers; for engineering counsel or specific proposals, call in a Morganite sales engineer. Either way, there is no obligation.

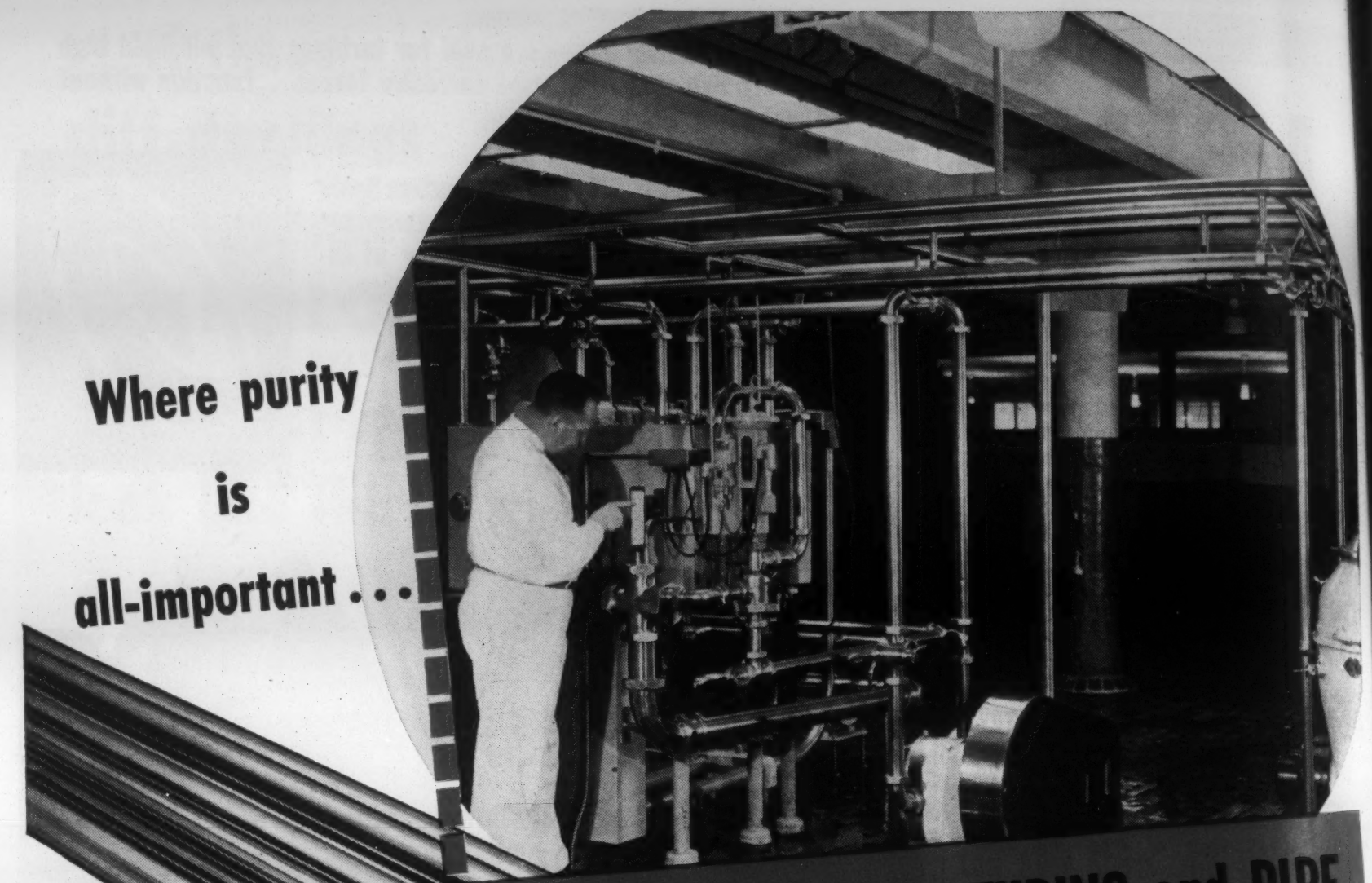
REGISTERED TRADE MARK Morganite INCORPORATED

LONG ISLAND CITY 1, NEW YORK





Manufacturers of Morganite Carbon Brushes for all motor and generator applications, and Morganite Carbon Piles.



Where purity is all-important . . .

. . . choose ELECTRUNITE STAINLESS STEEL TUBING and PIPE

In this modern midwestern dairy, all process tubing and piping are made of easy-to-clean, sanitary stainless steel tubing and pipe. And in keeping with the bright, gleaming appearance of the processing equipment, even the air lines and electrical conduit are made of stainless steel tubing.

● In the processing of food, chemicals, pharmaceuticals and many other products, there can be no compromise with cleanliness, sanitation and freedom from contamination. That's why ELECTRUNITE Tubing and Pipe—made of gleaming Republic ENDURO Stainless Steel—are widely used for countless applications in these fields.

Because stainless steel inherently is a sanitary, non-contaminating material, ELECTRUNITE Stainless Steel Tubing automatically affords these basic advantages. And as produced by Republic's *improved* electric welding processes, this *modern* tubing is uniformly ductile, strong, sound and round . . . free from scale and scale pits both inside and out.

Where purity is all-important, the extra cost of stainless steel is extremely inexpensive insurance against sub-standard product quality. For complete information about ELECTRUNITE Stainless Steel Tubing and Pipe, write today for the name and address of your nearest ELECTRUNITE Distributor.

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION • CLEVELAND 8, OHIO
Export Dept.: Chrysler Bldg., New York 17, N.Y.

Republic
REPUBLIC STEEL REG. U.S. PAT. OFF.
ELECTRUNITE
STAINLESS STEEL TUBING

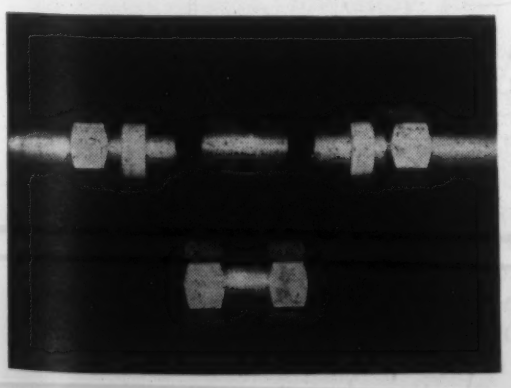
New Materials and Equipment

New Tube Fitting Eliminates Threads

A new type union that makes possible the use of light or heavy gage stainless tubing in place of pipe has been introduced by the *Steel Products Corp.*, 52 Vanderbilt Ave., New York 17. No threads on the tube ends are employed. The ends of the tubing are butted together through the union body; special grip nuts are then tightened to complete the joint.

The body of this union, called Sta-Union, is stainless steel. Gaskets of the standard stock are of a special plastic, resistant to heat up to 400 F; they also resist attack of acids, organic materials, strong alkalis, but not molten alkali metals. The standard grip nuts are of mild steel; stainless steel grip nuts are also available.

Advantages claimed for the union are that it is corrosion resistant, it insures a dependable tight joint, eliminates tube threads imparting added strength and facilitates installation. The unions are suitable for working pressures up to 150 psi. and are available for outside tube diameters from ¾ to 2¼ in.



Parts of new tubing union shown here include a threaded body, two gaskets and two grip nuts.

Gallium Metal Now Available

Gallium, a rare, silvery-white metal of unique properties, is now being produced by the *Aluminum Co. of America*, 801 Gulf Building, Pittsburgh 19. This unusual metal has a melting point of 86 F, but it will not boil until heated to approximately 3700 F. Gallium shows a strong tendency to undercool, and the liquid metal may be held for some time at temperatures almost as low as the freezing point of water without solidification taking place.

Though similar to aluminum in its chemical behavior, gallium is not a light metal. Its density (5.9) is about twice that of aluminum, but only about half that of metallic mercury, which is also liquid at room temperatures. Like water, but unlike most elements, the density of gallium is greater as a liquid than as a solid; gallium actually expands on solidifying.

Gallium wets many types of non-metallic surfaces, such as glass and porcelain. As in the case of aluminum, a protective natural oxide film forms readily on the surface. Even when heated to temperatures as high as 1000 F, a globule of gallium will remain bright and shiny. This combination of properties should make possible a variety of unusual applications for gallium.

The low concentration of gallium in ores, and attendant difficulties of production, have been a hindrance to the development of uses for this rare metal. However, metallic gallium of high purity now is being produced from the oxide. As a result of these accomplishments, it is possible to offer metallic gallium in limited quantities.

● A new mold release material developed to meet difficulties frequently encountered in the plastics industry has been announced by the *Bee Chemical Co.*, 13799 South Ave "O", Chicago 33. Called Logolube, the new material is a liquid and does not interfere with painting of the molded parts. If desired, it can be removed from the plastic by wiping with a cloth wet with alcohol. It can be thinned for spraying on the mold or can be applied with a brush.

New Materials and Equipment

(CONTINUED)

Industrial Box Furnaces Feature Embedded Elements

A new series of industrial box furnaces is being offered by the *Cooley Electric Manufacturing Corp.*, 38 S. Shelby St., Indianapolis 7, Ind. The heating elements for these furnaces consist of resistors which are embedded in ceramic slabs. In the side walls they are so placed that an air space is left behind, above and below the slab which then forms a baffle wall, creating a natural convection when heated. This arrangement is said to not only equalize furnace temperatures but causes cool operation of the element and furnace wall, the effect being rapid heating, uniformity of chamber temperatures, and economy in operation. The quick removal of heat from both sides of the element greatly lengthens element life.

Another feature of the furnaces is the door that completely covers the operating end of the furnace. It insulates the front section equally with the other furnace walls. This type of door eliminates the need for heavy fire brick in the vestibule and in the door.

A full automatic control either mounted in a completely wired control panel including multi-breaker line switch and fuses or arranged so that the control and switch equipment can be mounted on a wall separate from the unit is supplied with the furnaces. Where the control apparatus is mounted in the control panel, it becomes an integral part of the furnace and forms a complete unit that requires only connecting into a 230-v. single or three-phase power line to put the furnace into operation. All standard types of pyrometers are available and can be specified to suit the user's desire or requirements.

Models BL-1, 2 and 3 industrial box furnaces are supplied in the following three sizes: chamber dimensions—12 in. wide by 8 in. high are common to all three models. Respective lengths are 18, 24 and 36 in., with power inputs of 11.5, 14 and 18 kw. They are built for maximum heating temperatures of 1850 F, and are offered for either single-phase or three-phase 230-v. operation.

View of new electric box furnace with door closed.

Developments in Cleaning and Pickling Products

Metal Conditioners

Two new phosphoric acid cleaners for metals have been announced by *Klem Chemicals, Inc.*, Dearborn, Mich. The products are known as Rust-Sol No. 123 for wash-off or immersion type of cleaning, and Rust-Sol No. 113 for wipe-off or hand application. Both cleaners feature good wetting and dispersion qualities. They emulsify all oil and grease, and penetrate the oil coating to the steel surface, where they dissolve rust and oxide with a reaction that leaves a protective iron phosphate coating. Welding flux, soldering acids and other corrosive salts are dissolved and neutralized by these two new cleaners.

Other features are: safe, non-hazard cleaning that can be used anywhere in the plant on any parts, no matter what the size; eliminates the necessity of explosive solvent cleaning as well as chlorinated degreasers; improves the paint bond and paint life.

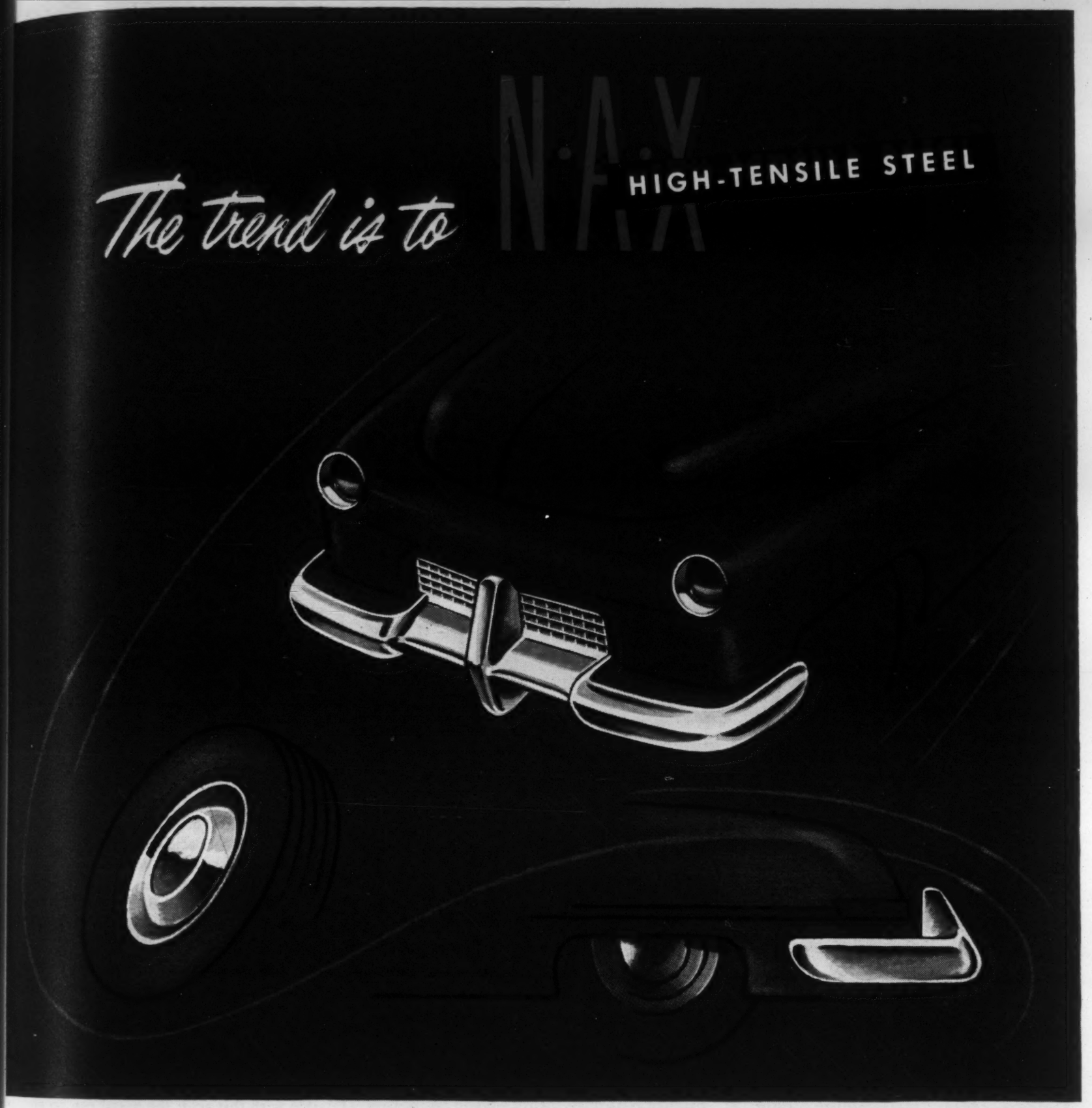
Rust-Sol No. 123 can be used at dilutions of 3 to 4 parts of water. This same cleaner used at approximately ½ of 1% by volume makes a good rinse after alkali stripping to provide a positive base for painting. Rust-Sol No. 113 works with dilutions containing 2 to 3 parts of water. It is non-toxic, non-inflammable and non-corrosive.

Synthetic Cleaner

A synergized synthetic cleaner developed by the *Quaker Chemical Products Corp.*, Conshohocken, Pa., is suitable for the removal of mineral oil type soils. This powder type product is used at concentrations of 2 to 3 oz. per gal. with water as a tank type cleaner in the temperature range of 180 F to boiling, and will prepare metal surfaces for bonderizing, electroplating, painting, and other critical operations with immersion times of less than 2 min. in the cleaning cycle.

The cleaner can be applied to the cleaning of steel, brass, die casting and aluminum. With the latter material, the fine

The trend is to N·A·X HIGH-TENSILE STEEL



Since 1940, when Great Lakes Steel pioneered the application of high-tensile, low-alloy steel to cold-stamped automobile bumpers, there has been a growing trend to N-A-X HIGH-TENSILE steel in the automobile industry.

Today, every car manufacturer is using the inherent better properties of N-A-X HIGH-TENSILE steel for some part of his automobile.

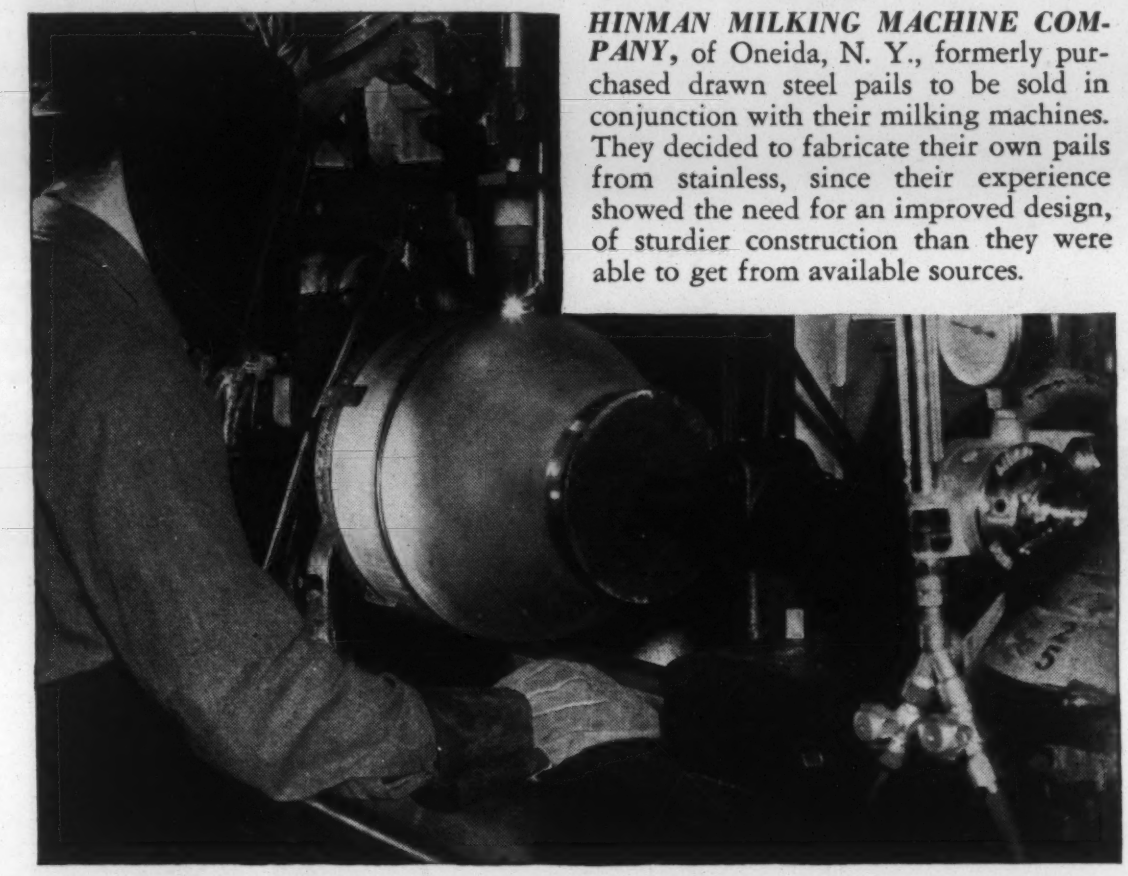
Bumpers and grilles—hoods and fenders—body panels and deck lids—frames and bracings—wheels and hub caps represent a few of many applications of N-A-X HIGH-TENSILE steel to the modern car.

MAKE A TON OF SHEET STEEL GO FARTHER
Specify— N·A·X HIGH-TENSILE STEEL

N-A-X HIGH-TENSILE MEETS ALL REQUIREMENTS OF S.A.E. 950

GREAT LAKES STEEL CORPORATION N-A-X ALLOY DIVISION • DETROIT 18, MICHIGAN
Unit of National Steel Corporation

Machine Heliwelding turns out a better milk pail at lower cost



HINMAN MILKING MACHINE COMPANY, of Oneida, N. Y., formerly purchased drawn steel pails to be sold in conjunction with their milking machines. They decided to fabricate their own pails from stainless, since their experience showed the need for an improved design, of sturdier construction than they were able to get from available sources.

John View, Airco Technical Sales Representative, was consulted and he suggested the Heliwelding process with the Airco machine holder, using Airco Helium. After Heliwelding, only a small amount of polishing was necessary to finish the job, making the cans ready for shipment.

This method was so successful that the customer was able to produce a top quality pail with a tidy saving in money — and time.

• • • •

TECHNICAL SALES SERVICE — ANOTHER AIRCO PLUS-VALUE FOR CUSTOMERS

To assure its customers of high efficiency in all applications of the oxyacetylene flame or electric arc, Air Reduction makes available the broad, practical experience of its nationwide Technical Sales Division personnel. The collective experience and knowledge of these specialists has helped thousands to a more effective use of Airco processes and products. Ask about this Airco "Plus-Value" service today. Write your nearest Airco office. In Texas: Magnolia Airco Gas Products Company . . . On West Coast: Air Reduction Pacific Company.

AIRCO **AIR REDUCTION**

Offices in All Principal Cities

Headquarters for Oxygen, Acetylene and other Gases . . . Carbide . . . Gas Welding and Cutting Machines, Apparatus and Supplies . . . Arc Welders, Electrodes and Accessories

New Materials and Equipment

grained but superficial etch provided yields unusually good paint adhesion.

Paint Stripper

The new types of urea melamine, vinyl, and bis-phenol finishes of both the air dry and baked type can be stripped in less than 5 min. without hazardous solvent or special equipment, using a new paint stripper produced by the *Quaker Chemical Products Corp.,* Conshohocken, Pa. This product is applicable to both the new and old type finishes so that the necessity of maintaining a special stripping bath for either class of work is unnecessary.

Pickling Acid

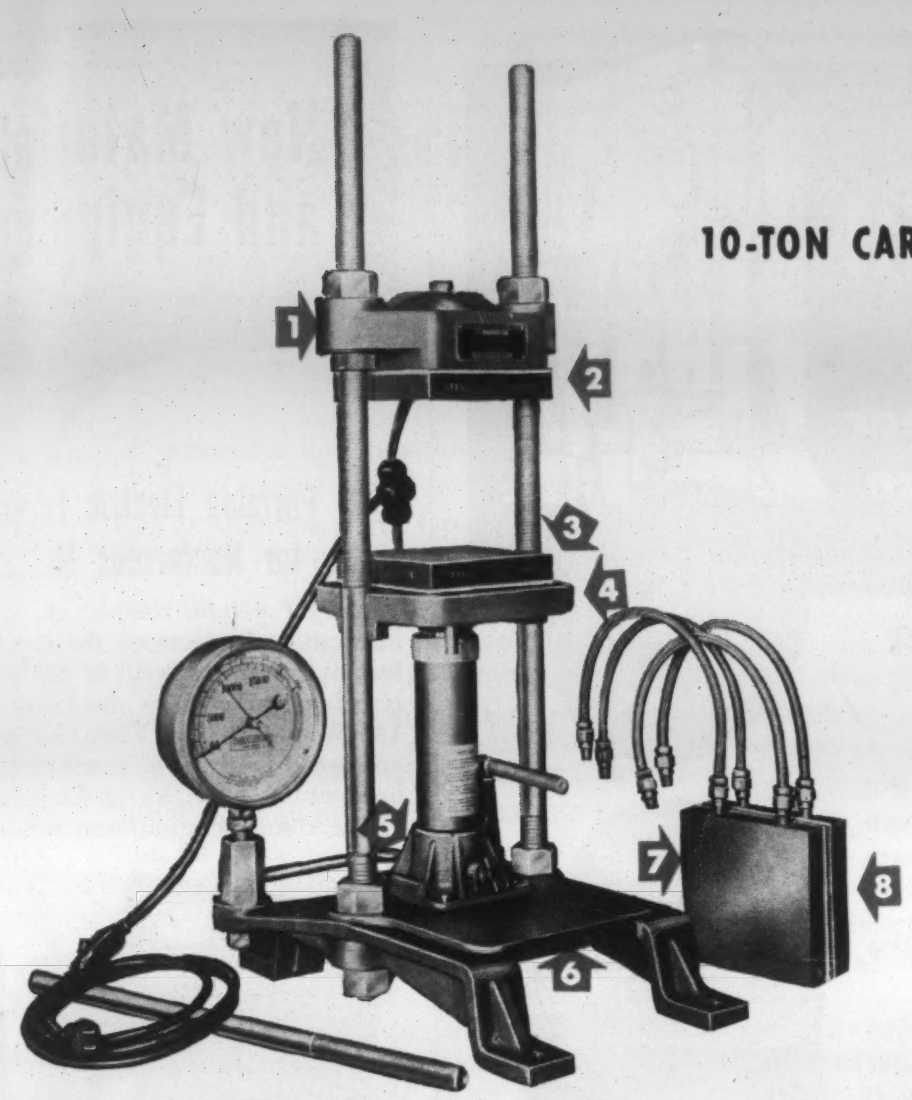
A compounded pickling acid produced from a phosphoric acid base and incorporating a correct balance of other acids and inhibitors to prevent it from attacking the base metal has been developed by *Nielco Laboratories,* Detroit 19. It contains neither sulfuric nor hydrochloric acids, and is put up in a concentrated liquid for mixing with water.

The pickling acid can be used at the ratio of 1 to 3 (25% acid) or at a ratio of 1 to 4 (20% acid) and at a temperature of about 185 F. A concentration of 1 to 3 will remove mill scale from 10-gage hot rolled steel in a 5-min. cycle. Thus, it is equal to sulfuric acid in its pickling action.

With this pickling solution the same tankful can be used continuously with occasional build-up to maintain the acid at full working strength. The acid presents no hazards and gives off no fumes.

A high degree of corrosion control of the metal after pickling is said to be possible with this acid; the metal can be pickled and rinsed in hot water and, without going through the neutralizing operation, remain free of corrosion for some time, often several days.

● The *Alloy Rods Co.,* of York, Pa., has announced a new a.c.-d.c. stainless welding electrode which is said to embody a number of improvements over the conventional a.c.-d.c. electrodes. The electrode has excellent arc starting qualities on all types of a.c. welding equipment. It has a smooth, stable arc with fine-spray weld metal transfer. The slag is easily and completely removed, leaving no secondary film. The bead is uniform and full throated with straight-line, feathered edges.



10-TON CARVER LABORATORY PRESS

1, 4, 6 Frame Parts: Head, Moving Platen, and Base.

2, 3 Electric Hot Plates for temperatures to 600°F.

5 Hydraulic Cylinder Unit Base for operation at 16,000 psi.

7, 8 Steam Hot Plates for intermittent use with steam to 200 lbs. and cold water.

Precision Equipment Demands Dependable Meehanite® Castings

FRED S. CARVER, INC., New York, N. Y., manufacturers of the Carver Laboratory Press illustrated make extensive use of Meehanite castings in the construction of their various press units. The castings are indicated, and quickly reveal the superior engineering properties which must be provided in order to meet the design specifications.

Note the hydraulic cylinder unit which is designed for repeated operations at 16,000 psi. Note also the electric hot plates which must maintain their dimensional stability after repeated submission to temperatures up to 600° F.

These units were designed for and have been built with Meehanite castings for many years, and thousands of them are giving trouble-free service all over the world. This is another example of the proper combination of good design plus the specification of Meehanite castings for better components, providing regularly the correct combination of engineering properties.

We have a Bulletin 30 entitled "Meehanite Means Better Castings" which describes a series of similar production and specification problems solved through the use of Meehanite castings. For a copy write to any of the foundries listed.

MEEHANITE FOUNDRIES

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co.	Portland, Oregon
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Indiana
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
U. S. Challenge Co.	Centerville, Iowa and Batavia, Illinois
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey
E. Long Ltd.	Orillia, Ontario
Otis-Fensom Elevator Co., Ltd.	Hamilton, Ontario

"This advertisement sponsored by foundries listed above."

Meehanite® NEW ROCHELLE, N. Y.

AMPCO Metal can really take it!

Exceptional strength... high fatigue limits... wear resistance and resistance to impact

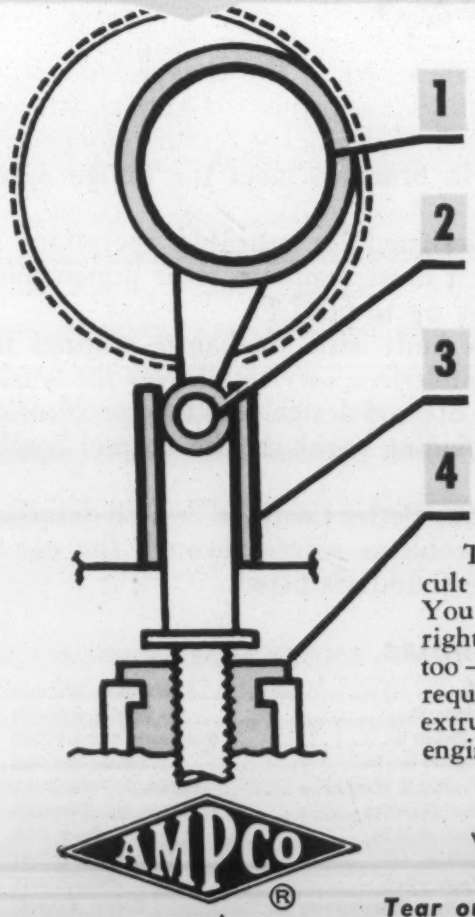
—just the material for your tough jobs!

Possibly you don't make or use heavy presses. But probably you *do* have jobs for Ampco Metal — tough jobs where you need the same superior performance that Ampco Metal gives in these press applications.

***Ampco 24 Extrusion Punch Outlasts the Best Steel 10 to 1**

The extrusion punch at the right extrudes a 5/8" hole to 3¼" diameter in a heavy gauge steel water heater head. The best steel punches produced 6600 pieces *maximum*. With the new Ampco Grade 24 punches runs of 65,000 pieces became *average*.

Ampco Bronze in the Press itself!



Bronze eccentric bushings — Ampco Grade 12 Bushings, centrifugally cast, provide a wear-resistant eccentric bearing lining that gives maximum heavy-duty service.

Bronze wrist-pin bushings — Ampco Grades 18, 18-23, or 20 centrifugally cast bushings withstand extremely heavy loads without mushrooming. (Ampco field engineers will be glad to recommend proper grade.)

Bronze-lined guides — Ampco 8 Sheet used as liners (gibs) give maximum life with minimum wear under varying conditions of load, speed, etc.

Bronze liner and locking nut — Ampcoloy E-123 (centrifugally cast) affords up and down adjustment of shutting height without galling and with minimum wear.

These few examples illustrate some of the difficult jobs which Ampco alloys handle with ease. You can select a grade of Ampco Bronze that is right for your production and maintenance needs too — produced by the method best suited to your requirements: sand or centrifugal castings, sheet, extruded rod, etc. See your nearby Ampco Field engineer for specific recommendations.

AMPCO METAL, INC.
MILWAUKEE 4, WISCONSIN
West of the Rockies it's the Ampco Burbank Plant, Burbank, Calif.

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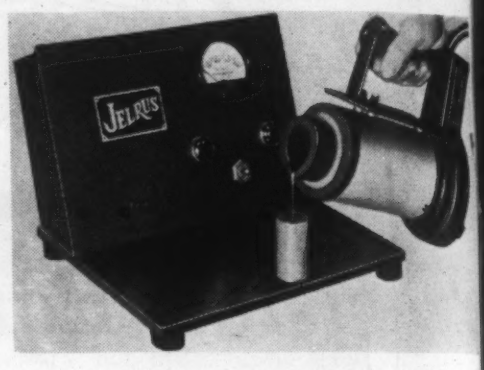
New Materials and Equipment

Portable Electric Furnace for Nonferrous Metals

A light weight, compact electric furnace that can melt many of the common nonferrous metals as well as precious metals is being marketed by the *Jelrus Co., Inc.*, 136 W. 52 St., New York 19. The melting unit weighs only 5 lb., is self-contained, and operates on 110 v., a.c. or d.c. current.

The complete equipment consists of the



Liquid metal being hand poured from the portable electric furnace.

melting unit and a temperature indicator and control. A graphite crucible provides a reducing atmosphere and eliminates dangerous oxidation of metal during melting.

This portable electric furnace can be used for small quantity melting, alloying and casting operations. Its capacity for brass is 1½ lb., for silver 25 Troy oz., and for gold 30 Troy oz. It is capable of temperatures up to 2000 F. It occupies a space 12 by 10 by 9 in. high.

Uniform Tungsten Powders Available for Carbide Tools

Commercial production of fine tungsten powders, with accurate and predictable particle size and distribution for use in tungsten carbide tools, has been achieved by the *Tungsten & Chemical Div., Sylvania Electric Products, Inc.*, Towanda, Pa. The problem of control of these two physical properties, according to the company, has heretofore been possible only by expensive, time-consuming laboratory control, impracticable for commercial production. The new control method, being used in commercial production, now makes it possible to supply material to meet tool makers specifications without varying their processing.

Carbide cutting tools are made by pres-

ASK STOKES

Precision Parts by Powdurgy* At Lower Cost

DESIGNERS find powdurgy offers unlimited opportunities for low cost production of precision parts. Operating time is reduced to the vanishing point. Impressive savings are made on material. High labor costs for casting and machining are eliminated. And capital investment for powdurgy equipment need not be burdensome.

Powdurgy makes some things (like sintered carbides and porous bearings) which can be made no other way . . . does some things (like bonding metals and nonmetals) which can be done no other way . . . and daily performs its economies for an ever-widening circle of manufacturers.

Now it is a rare day when we don't guide some manufacturer in his choice of presses for powder metal production, or counsel him to avoid it in his current circumstances.

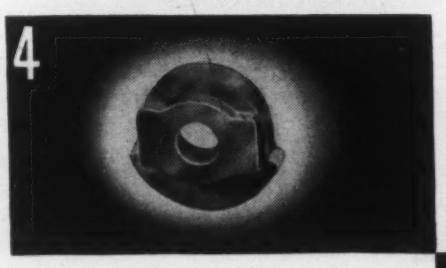
It may pay you to investigate powder metallurgy. Although we do no fabricating of powder metal parts, we shall be pleased to advise on the suitability of this process for your needs. Send your blueprints or sample parts to

F. J. Stokes Machine Company,
5972 Tabor Road, Phila. 20, Pa.

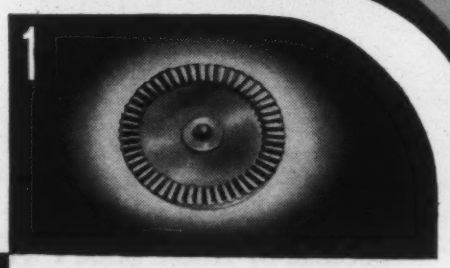
Stokes makes Vacuum and Special Processing equipment, High Vacuum Pumps and Gages, Pharmaceutical equipment, Industrial Tabletting and Powder Metal Presses, Plastics Molding Presses, Water Stills and Special Machinery.

**Stokes' word for the theory and practice of making finished solid products from granular materials.*

Illustrated are typical parts made of powder metal.



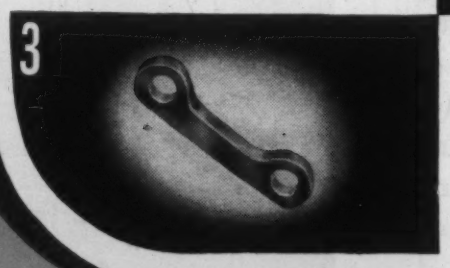
1 This powder metal gear replaces machined forged part at a saving of 25%.



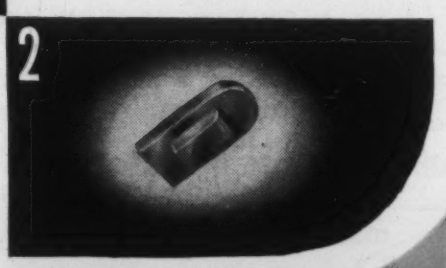
4 This ball race was originally a 2-piece assembly . . . now made in one piece from powder metal at a saving of 80%.

Stokes does not fabricate powder metal parts, but will advise on the suitability of the process for your needs. Send your blueprints or samples.

2 This contact lug in powder metal replaces swaged and coined part from bar stock at saving of 60%.



3 This link, formerly stamped and coined, is now produced from metal powder at a saving of 50%.



STOKES KNOWS HOW

Meehanite®

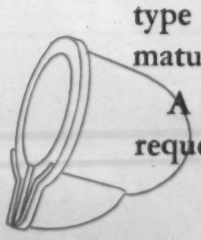
MELTING POTS

by

Brake Shoe

A reliable and economical source of melting pots is found in castings by Brake Shoe of Meehanite metal. *Reliable* because of Brake Shoe's wide metallurgical knowledge and thorough foundry techniques that protect structural soundness and physical properties. *Economical* because of the longer life expectancy of a sound casting closely matched to its service.

In melting pots, Brake Shoe uses a type of heat-resisting Meehanite chosen to withstand constant heating, intermittent heating and cooling, flame impingement and contact with molten metals. Whether you require the type used for melting aluminum or that for melting lead or zinc, pouring type or holding type, count on these castings to resist premature cracking, warpage, growth, oxidation and corrosion.



A list of available sizes and prices will be sent you on request.

7320

AMERICAN Brake Shoe COMPANY

BRAKE SHOE AND CASTINGS DIVISION

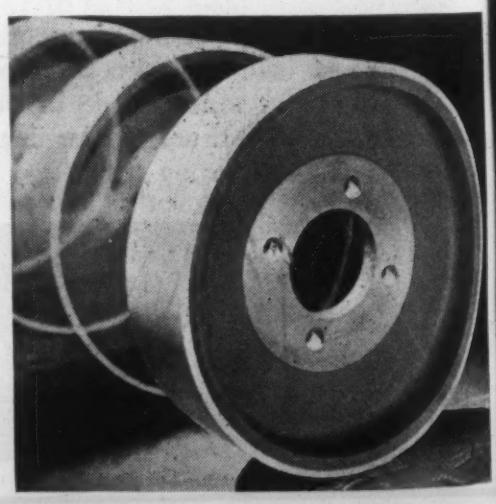
230 PARK AVENUE, NEW YORK 17, N. Y.

ing and firing carburized tungsten to which cobalt is added as a "binder." Size and distribution of powders must be accurately controlled for a uniform end product which is, in fact, a solution of hard particles in cobalt, the cementing agent.

To make the tungsten carbide products, tungsten ore is successively processed into metal powders, sintered ingots and, finally, hot swaged rods and fine drawn wires. Some of the latter have diameters as fine as 0.0004 in.

Silicone Rubber Now Bonded to Metals

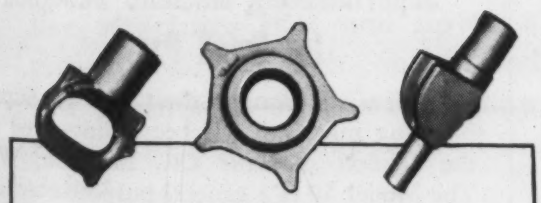
Silicone rubber can now be bonded to a wide range of metals, according to the *Stalwart Rubber Co.*, 165 Northfield Rd., Bedford, Ohio. This new development is recommended for such applications as gaskets on industrial ovens and commercial deep-freeze units, diaphragms to seal lubricants in high-speed bearings, suspension parts on conveyors that pass through high temperature drying chambers or dip tanks containing heated solutions, rubber tires on materials handling carts used in drying ovens, weatherproof or explosionproof sockets for floodlights, and certain applications in internal combustion and jet engines where a gas seal is required.



A layer of silicone rubber bonded to the periphery of an aluminum casting.

Silicone rubber can withstand temperatures ranging from a low of −160 F to a high of more than 500 F. In addition to being suitable for dielectric applications, silicone rubber parts are resistant to permanent compression even under extreme

Die-sinking: finishing a blanking impression at the Bethlehem Drop Forge Department.



What does Bethlehem offer in closed-die forging equipment?

A variety of steam and board drop hammers, 1500 to 8000 lb; mechanical presses to 2000 tons; and upsetters 9 in. and smaller. This battery of modern machines gives us ample capacity—and ample range of size—to take care of your requirements without delay.

BETHLEHEM STEEL

The expert die-maker is one of the real craftsmen of our times. His knowledge, experience, and skill are widely applied at the Bethlehem shops, where each year many intricate dies are made for the drop, press, and upsetter forgings we manufacture.

It goes without saying that accurate impressions in dies are vital to the production of good forgings. Bethlehem has long been known as a source of reliable forged products, and careful die-making contributes greatly to the quality of these products.

When in the market for closed-die forgings, let Bethlehem handle your needs. You will find our work dependable every step of the way — through all the various phases of steel-making, die-making, forging, treating, and inspection.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

With the PROFILOMETER, You're SURE!

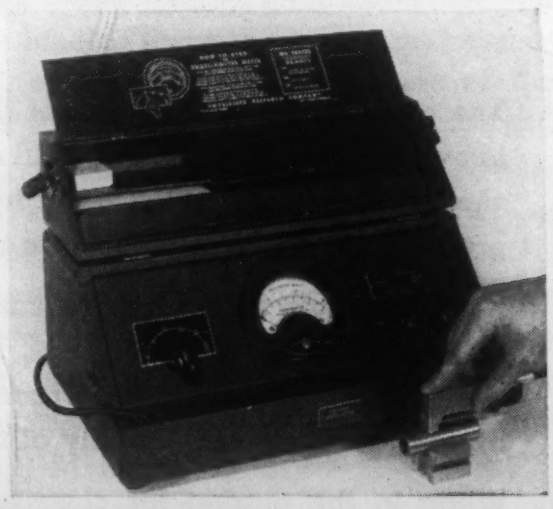
If you keep track of the condition of your tools by gaging the parts produced, you're likely to get some off-size pieces before resharpening. This is because, when a cutting edge or grinding wheel starts to grow dull, clean cutting action ceases and the metal begins to be *torn* off. *Once begun, this effect increases rapidly,* often leading to off-size work before it is detected by dimensional measurement.

If, instead, you resharpen on a fixed-schedule basis, you again run the risk of loss. If the schedule is based on using a *normal* tool or wheel, one that is even slightly defective will produce rejects before resharpening. Unexpected changes in hardness of metal or in other operating conditions may also cause premature dulling, with the same result. If the resharpening schedule includes a factor of safety to allow for such possibilities, most of the time resharpening will be done more frequently than necessary, thus shortening total tool life and increasing your down-time.

To avoid these difficulties—to get maximum production with maximum tool life and minimum rejects—more and more companies are using the Profilometer to detect the dulling of tools and wheels. This is how it is done:

As tools and abrasive grow dull, the cessation of clean cutting action (mentioned above) increases the normal point-to-point variation in the *surface roughness* of the work. This takes place just before *dimensional* errors occur. *By taking occasional roughness readings with the Profilometer on the parts as they come from the machine, the operator can quickly tell the condition of his tools or wheel. When the point-to-point roughness increases, he knows it's time to sharpen his tools or dress his wheel.*

Using the Profilometer, this simple shop procedure can be applied to any machining, grinding or finishing operation on practically any surface. The initial cost of the Profilometer is soon repaid by the savings effected thereby; and that is only one of many practical applications. *Write for further information*—and arrange for a demonstration in your plant.



Profilometer is a registered trade name.

A SURFACE CONTROL INSTRUMENT BY

PRC

PHYSICISTS RESEARCH COMPANY

ANN ARBOR • MICHIGAN

New Materials and Equipment

heat and withstand the effects of prolonged weathering. They have excellent water repellency and maintain high surface resistivity under moisture condensing conditions.

Silicone rubber is recommended for applications involving either hot or cold liquids or gases, or where rubber is subjected to other extreme hot or cold conditions. In addition, this synthetic will not become brittle and will not crack after long exposure to air, ultra-violet rays, or ozone, and it will not turn to carbon despite heat.

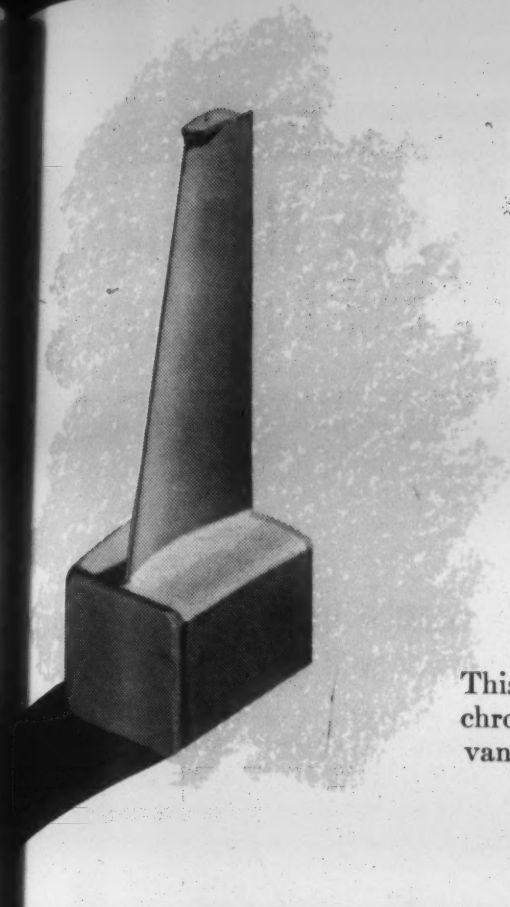
● A large size diameter electrode to handle heavy cast iron castings has been introduced by the *Eutectic Welding Alloys Corp.,* 40 Worth St., New York 13. This new rod, ¼ in. in size, is particularly adaptable for overlaying and repairing large turbines, pumps, impellers, mixers, cylinder heads, housings, and other heavy types of castings requiring a heavier, more substantial electrode. It is also available in sizes 3/16, 5/32, 1/8 and 3/32 in.

Superfinishing Machine Designed for Small Parts

A new addition to their line of Superfinishing machines has been announced by the *Gisholt Machine Co.,* Madison, Wis. The Model 50 is a general purpose machine designed to handle medium to small cylindrical parts.

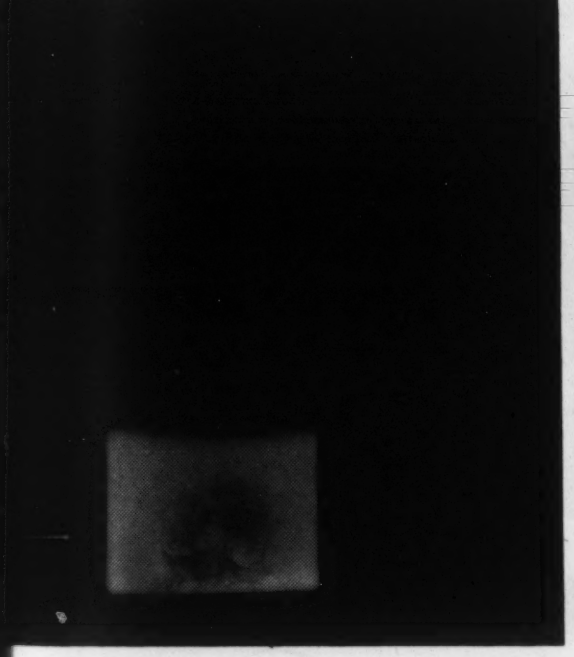
The machine has a capacity of 12 in. between centers, 8½-in. swing with a 3-in. maximum working dia. and a workpiece weight of 100 lb. It has variable spindle speeds from 40 to 1000 rpm., thus allowing the operator to select the proper speed for the degree of surface finish required. The quill is spring loaded and is adjustable from 0 to 45 lb. of pressure. The machine is equipped with an adjustable tailstock and a complete lubricant system.

Two standard machine attachments are available at this time, the motor-driven traverse attachment and the centerless roll drive attachment, which is for parts that have no centers. This machine is suited for small parts such as plug gages, hydraulic cylinders, pistons and shafts of all kinds.

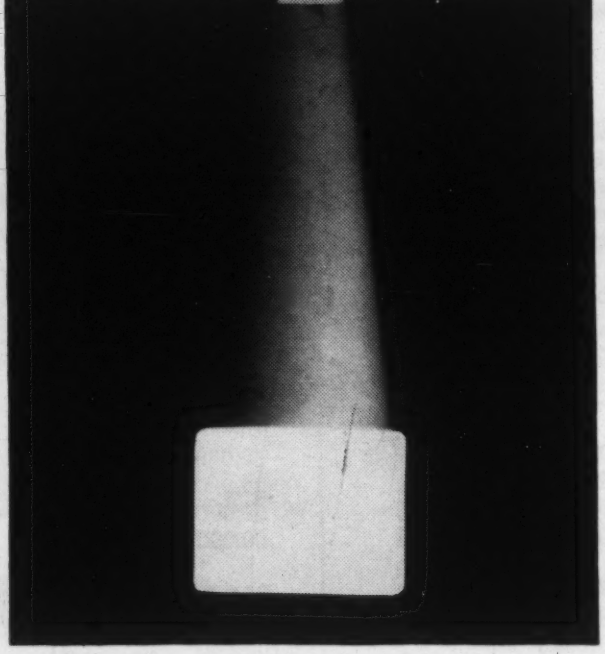


3 WAYS RADIOGRAPHY CAN PROVIDE INSIDE INFORMATION

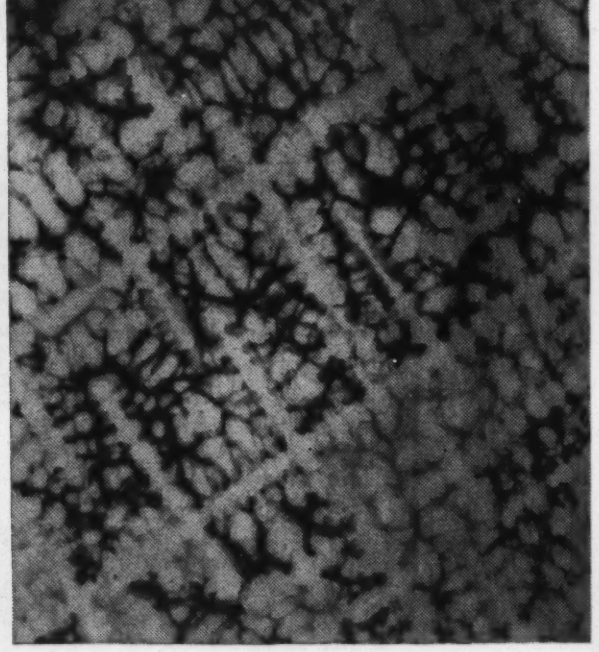
This is the example illustrated—a casting of cobalt-chromium-molybdenum alloy. It consists of a 1/16-inch vane extending from a 2-inch block.



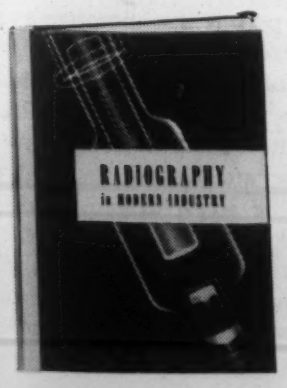
With million-volt x-rays on *Kodak Industrial X-ray Film, Type M*, the base of this dense casting shows fine structures that add up to a gross defect. The high contrast and low graininess of this film show clearly the size and character of the defect.



At 250 kv, another radiograph on *Kodak Industrial X-ray Film, Type M*, reveals a threadlike structure extending from a cavity near the end of the vane. Here, too, high contrast and low graininess are essential, and yet the film has adequate speed for reasonably short exposure.



At 25 kv, a microradiograph is made on a *Kodak Spectroscopic Plate, Type 548-O*, through a .005-inch section cut from the casting. At 35X enlargement, the extremely high resolution of this photographic material shows a rectangular array of crystal growth in which the lighter tone is interpreted as a molybdenum-rich phase. This is indicated by the relative opacity of molybdenum to x-rays, emphasized by the low kilovoltage.



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get a copy from your local x-ray dealer, price $3.

"Kodak" is a trade-mark.

EASTMAN KODAK COMPANY
Rochester 4, N. Y.

RADIOGRAPHY
— ANOTHER IMPORTANT FUNCTION OF PHOTOGRAPHY

Kodak

PLENTY OF FLEX BUT NO PERMANENT SET in this fishing rod made by Penrod Company. Beryllium-copper Tubing welded and drawn by Superior Tube Company.

Are YOU Looking for Properties the Fisherman Gets In This Rod Made of BERYLLIUM-COPPER?

and in addition —

STRENGTH AND HARDNESS. BERYLCO 25S, a readily machined and formed alloy, attains the highest strength and hardness of any non-ferrous material through a simple, low-temperature heat-treatment after fabrication. Moderately cold-rolled strip, which can take a 90 degree bend about a radius equal to stock thickness, reaches an ultimate tensile strength of 180,000 psi after heating for two hours at 600°F. The following table shows typical values for available tempers of BERYLCO 25S strip:

Strip Tempers	Tensile Strength	Elongation	Elastic Limit	Rockwell Hardness
Before Heat-Treatment				
Annealed	70,000	35	20,000	B60
1 No. Hard	80,000	10	35,000	B75
2 No. Hard	90,000	5	50,000	B90
4 No. Hard	100,000	2	60,000	B95
After Heat-Treatment				
Annealed	170,000	6	80,000	C37
1 No. Hard	180,000	4	90,000	C39
2 No. Hard	190,000	2	100,000	C41
4 No. Hard	200,000	1	110,000	C43

CORROSION RESISTANCE. Having the inherent corrosion resistance of copper, BERYLCO 25S is dependable in marine and industrial atmospheres without the addition of protective coatings which may abrade or crack in use. Beryllium-copper also is unaffected by "season cracking" and hydrogen embrittlement.

CORROSION-FATIGUE AND ENDURANCE. BERYLCO 25S offers the highest corrosion-fatigue strength of any good spring material, showing no loss of endurance in a salt spray. It is widely used in diaphragm and spring applications requiring long life. Typical endurance values for cold-worked and heat-treated material are given below:

Strip—in reverse bending	40,000—50,000 psi
Rod—rotating beam Wire—rotating arc compression spring	45,000—60,000

ELECTRICAL AND THERMAL CONDUCTIVITY. Heat-treated BERYLCO 25S has a conductivity of 23 to 30% that of copper. This, combined with excellent spring properties, accounts for its successful use in many current-carrying applications.

For more information as to how BERYLCO 25S furnished as rod, strip or wire, may solve your design problem, write to us today, giving full particulars.

BERYLCO BERYLLIUM

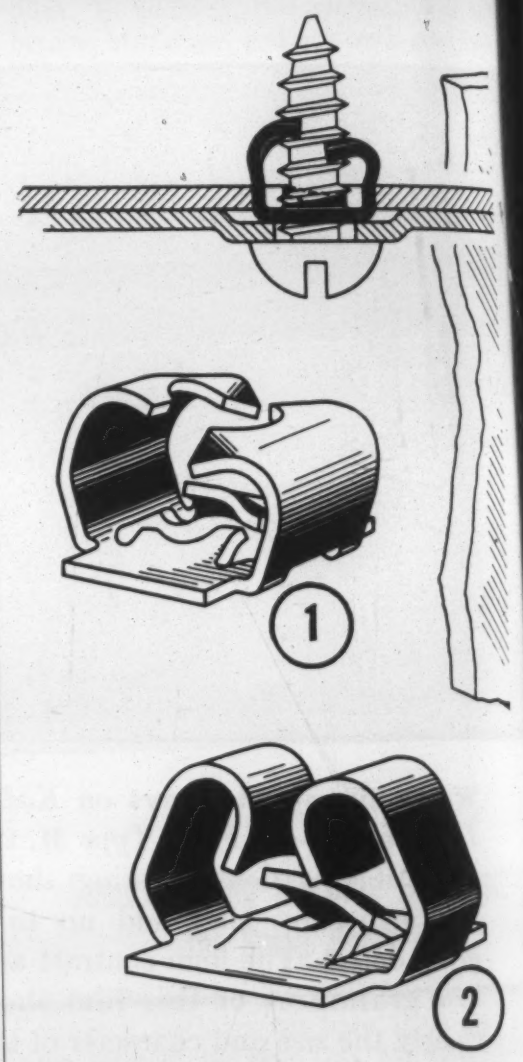
The **BERYLLIUM CORPORATION**

Dept. 4, Reading 3, Pa.

New Materials and Equipment

Assembly from One Side Possible with New Fastener

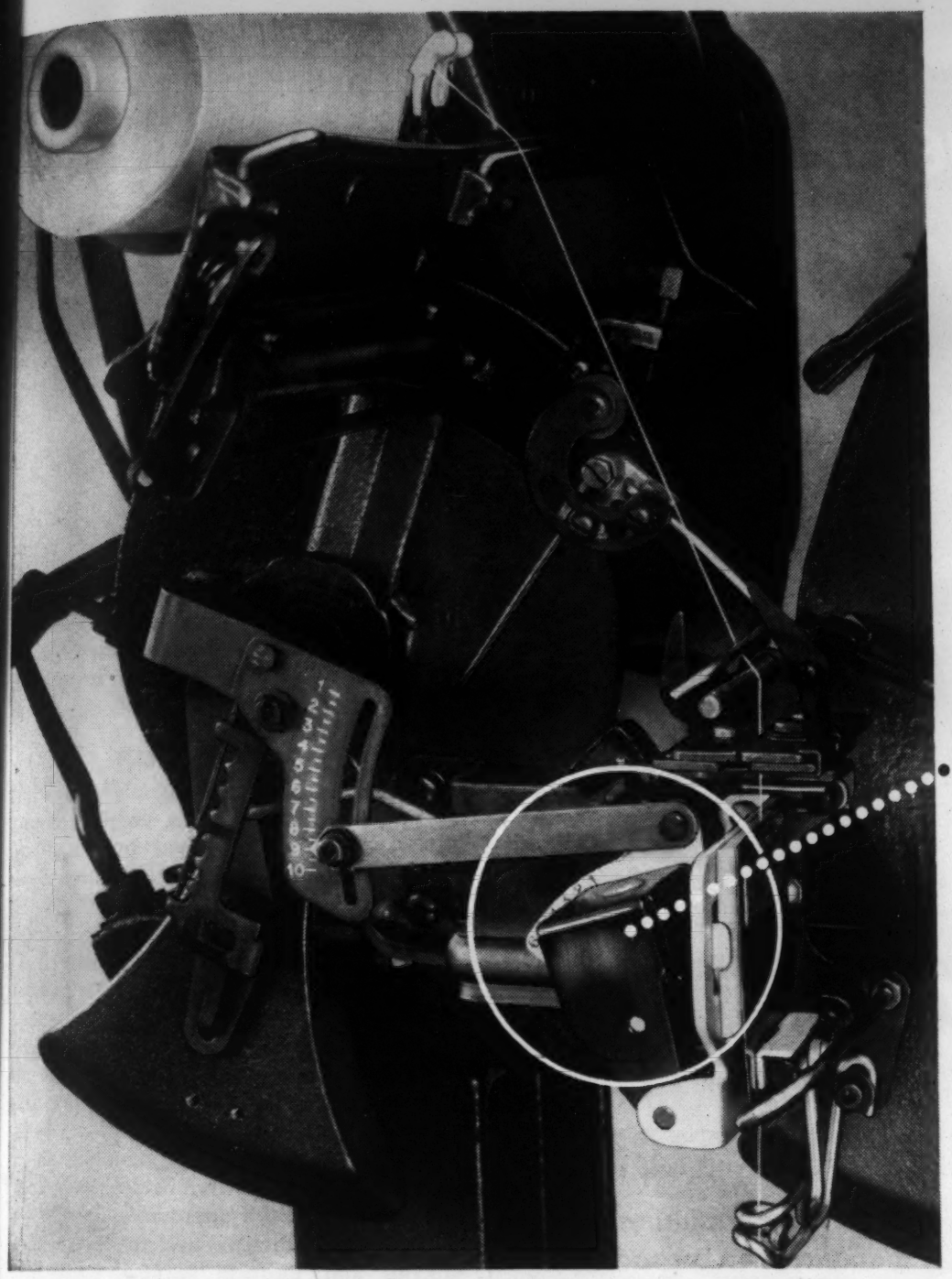
Blind assembly of parts to metal panels can now be accomplished quickly and efficiently with new expansion nuts, according to *Tinnerman Products, Inc.*, 2035 Fulton Rd., Cleveland.

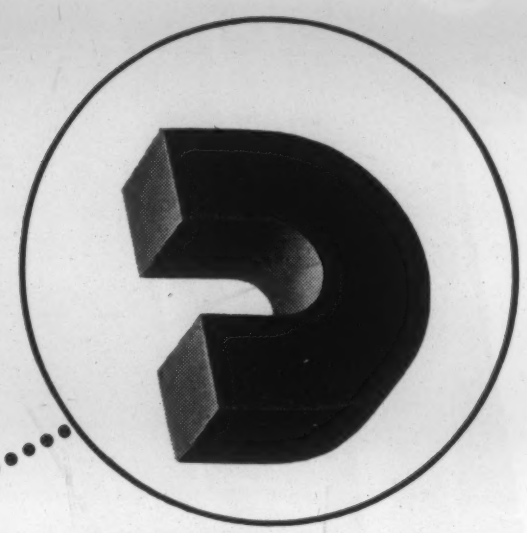


These Tinnerman expansion nuts are useful for blind assembly work.

These nuts permit the complete assembly to be made from one side and eliminate the necessity of two operators working on opposite sides of large panels. The nuts are inserted into square or round holes and the part to be attached is then placed in position and the screw driven. The special locking principle is embodied in the base for a secure vibration-proof fastening.

These expansion nuts are self-retaining and expand when a tapping screw is inserted. They are produced in two different basic designs: (1) having spring arms that are formed to grip at the root of the screw thread; (2) having spring arms turned under to "ride" on the crest of the screw threads.





The "Magnetension," a new yarn-winding tension control developed by Universal Winding Company, Providence, R. I., uses this *Indiana* permanent magnet.

INDIANA PERMANENT MAGNETS TAKE THE "KINKS" OUT OF YARN-WINDING

● Here's another job made simple by *Indiana* permanent magnets—they hold tension leaves against wear plates to provide even winding tension on yarn-winding machines. And here are the direct benefits: non-multiplying tension; fewer broken filaments; less end breakage, cut ends, or loops at cones; less attention to machines; *and a better product at less cost.*

"PACKAGED ENERGY" MAY BE *YOUR* ANSWER, TOO . . .

Indiana permanent magnets provide constant, *predetermined* force for *many* needs. In magnetic chucks and separators for holding and lifting . . . in snap switches and pressure devices for replacing springs . . . in magnetic drives for transferring motion through seals without mechanical connections . . . the list is practically endless.

HOW AND WHERE TO USE PERMANENT MAGNETS . . .

Write for free Book No. 4D-4—the new reference manual by *Indiana.* It shows how permanent magnets save space, weight, and money; lists applications; gives materials and design data. If *you* have an application problem, let's get our engineers together. The experience of forty years and more than 30,000 successful designs is at your call. Write *today.*

INDIANA PERMANENT MAGNETS

THE INDIANA STEEL PRODUCTS COMPANY

6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILLINOIS

SPECIALISTS IN "PACKAGED ENERGY" SINCE 1908

Actual Experience
of a LARGE AUTO PLANT
with the HOFFMAN OIL CONDITIONER

Reclaims
RUN-IN, LUBE HYDRAULIC AND OTHER INDUSTRIAL OILS TO NEW OIL SPECIFICATIONS
Pays for Itself

During the first 4 weeks of operation, a prominent automobile manufacturer reconditioned 50 drums of hydraulic oil to a like new condition with the Hoffman Oil Conditioner shown above. A saving equal to the cost of 50 replacement drums of new oil was effected—for only $2.59 for one change in the filter cartridges. The savings in replacement oil costs alone will more than pay for the unit within eight months.

In your case too, a fully automatic, push-button controlled Hoffman Oil Conditioner will increase productivity—save maintenance and cut operating costs. Write for all the details NOW!

Removes Solubles and Insolubles

Complete purification of used oil is accomplished simply, economically and conveniently. Unit consists of Hoffman Cartridge Filter (to remove all insoluble material) and Hoffman Vaporizer (to remove all soluble impurities.) Portable if desired . . . filter and vaporizer may be operated together or independently. No steam or water hook-up . . . complete with all electric and pump connections.

Capacities for 50 to 600 g.p.h. Write for Bulletins A-667 and A-668.

U. S. HOFFMAN MACHINERY CORPORATION
223 Lamson St., Syracuse, N. Y.
COOLANT FILTERS • FILTRATION ENGINEERING SERVICE

New Materials and Equipment

New Finishes and Coatings

Synthetic for Metals and Plastics

Development of a synthetic finish which has good adhesion on highly polished brass, stainless steel, aluminum and other surfaces that ordinarily resist adhesion of organic coatings has been announced by the *Metric Lacquer Manufacturing Co.*, 62 Woolsey St., Irvington, N. J. Tests conducted by the producers on polished brass show that this coating withstands a 28-in. Gardner impact test, and a 180-deg. bend over a ⅛-in. mandrel, without cracking or flaking. Similar results have been demonstrated on stainless steel and aluminum test panels.

On most thin gage metals baking is accomplished at 275 F for 15 min. For brass and for thick gages of other metals somewhat longer baking at slightly higher temperatures is recommended. Although designed primarily for metal surfaces, this synthetic is applicable to phenolic plastics. However, when applied to phenolics, due to lower heat conductivity, baking is accomplished at 300 F for approximately 45 min.

The new synthetic is said to have a hard, smooth and uniform surface with high resistance to chemicals, solvents and abrasion. It is produced in all colors, prepared specifically for spray application. Variations which will permit dipping and roller coating methods are also available.

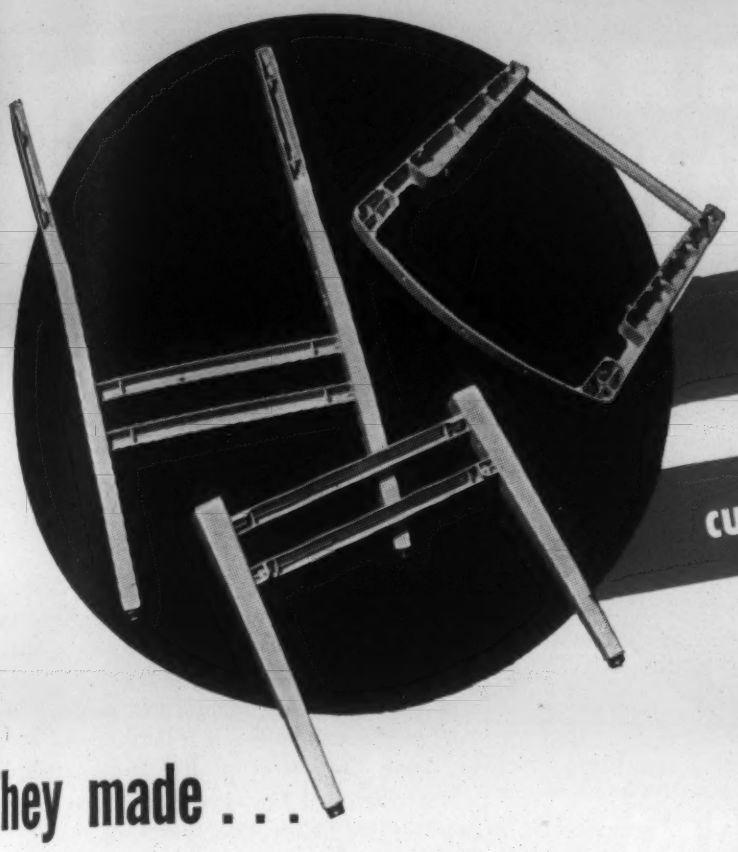
Tumbling Lacquer

The *Metric Lacquer Manufacturing Co.* has also announced the development of a "tumbling" lacquer designed specifically for metal parts which can be economically coated in tumbling equipment. The new lacquer is said to materially reduce the number of coats required for complete coverage, and can be applied uniformly without the difficulties commonly experienced in barrel work. Available in a variety of colors, this new lacquer offers ease of application, high coverage with fewer costs, high resistance to "sticking," and good adhesion.

Aluminum Finish

Special Chemicals Corp., 30 Irving Place, New York, has announced a new coating, called Spekaluminite, for dipping or spraying. The coating is said to adhere well to all metals and plastics and will not peel or flake. It is said to air dry in 5 min. One spray coat is reported to withstand salt spray on cold rolled steel over 200 hr.

The finish has the luster and sheen of bright cadmium. It has a temperature resistance of over 700 F, and laboratory tests have shown no appreciable change in color,



MAGNESIUM DIE CASTINGS . . .

cut weight . . . cut fabricating costs . . .

They made . . .

pounds and parts disappear . . .

in this folding chair!

High fabricating costs literally vanished when this chair was designed in magnesium.

The 3 major parts illustrated plus 2 smaller die castings replaced 14 separate parts used in previous construction. The use of die castings made possible lighter and more efficient sections—metal is placed only where it is needed for strength, styling and assembly. Considerable machining and finishing were eliminated, too, because magnesium can be die cast to close tolerances.

Magnesium die castings provided economy and latitude in styling of chairs since several models can be made using the same basic parts. Attractive, durable finishes were used to further improve appearance.

The manufacturer of this chair solved two other important problems when he switched to magnesium: First, serviceability—magnesium will not warp, crack, or splinter; Second, *availability—magnesium is readily available and priced more favorably than ever before.*

Manufacturers of countless products find that it pays to use magnesium—it can pay for you, too.

Magnesium Pays

Write for this revealing free book "How Magnesium Pays". It's filled with actual case studies of how manufacturers of a wide range of products have found that magnesium pays.
Send me the study MP 49-37 "How Magnesium Pays."

NAME_____

TITLE_____

FIRM_____

ADDRESS_____

MAGNESIUM DIVISION • THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle • Dow Chemical of Canada, Limited, Toronto, Canada

HYDROGEN and NITROGEN from AMMONIA

Barrett Standard Anhydrous Ammonia, 99.95% NH_3, oxygen free, with a very low dew point, is an economical source of pure hydrogen and nitrogen. When dissociated, each pound produces approximately 34 cubic feet of hydrogen and 11 cubic feet of nitrogen.

Engineers have discovered many advantages from the use of dissociated anhydrous ammonia in the production of controlled atmospheres in furnaces for bright annealing, clean hardening, copper brazing, sintering, reduction of metallic oxides, atomic hydrogen welding, radio tube sealing and other metal-treating practices. Anhydrous ammonia also has unsurpassed qualities in nitriding of steel, used as ammonia gas or dissociated.

Metallurgists are effecting real economies by using Barrett Standard Anhydrous Ammonia as a replacement for other more expensive sources of hydrogen and nitrogen. For information, contact Barrett, America's leading distributor of ammonia.

Barrett

STANDARD ANHYDROUS AMMONIA

Barrett Standard Anhydrous Ammonia is available in 50, 100 and 150-pound cylinders from stock points located from coast to coast.

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 RECTOR STREET, NEW YORK 6, N. Y.

New Materials and Equipment

flexibility or durability at a temperature of 1000 F.

Metal Brightener

A brightener for copper, brass and bronze has been developed by *Kelite Products, Inc.*, Box 2917, Terminal Annex, Los Angeles 54, Calif. The new product, Metal Brite, is said to be fast acting, and to have a long life. It is highly concentrated, and is economical because when used, one part is diluted with two parts of water. The compound gives natural colors to copper, brass and bronze, and gives a fine degree of polishing. The brightening operation takes 15 to 30 sec.

Rust Resisting Paint

A rust inhibitor paint providing good corrosion resistance and adhesion is being marketed by the *Al-Tex Products Co.*, Sales Div., 1900 Euclid Ave., Cleveland. This product, named End-O-Rust, prevents oxygen, acids, salts, and other elements from contacting the metal and setting up a galvanic action or incipient deterioration.

It has a low acid value and a low oxidation rate. It is especially suited for its ability to withstand extreme conditions of expansion or contraction and corrosive elements.

The finish is formulated in Type No. 1 for inside use and Type No. 2 for outside use, and can be applied by brush, spray or dip methods. When used as a primer the life of the second coat will be practically doubled, it is claimed. Coverage is approximately 600 sq. ft. per gal., depending on the smoothness of the surface, and comes in a variety of colors, including white and clear.

Corrosion Resistant Plastic Coating

A line of corrosion resistant plastic coatings developed especially for the finishing industry for the protection of machinery, processing equipment and general factory maintenance where corrosives are used has been developed by the *Poly-Cyclo Products Co.*, 12400 Crossburn Ave., Cleveland.

The coating, termed CycLon, series NPC, is an easily applied, high solids synthetic paint for protecting metals, wood and ceramic surfaces. It air dries by solvent evaporation to an adhesive, hard wearing, flexible glossy coating without the necessity of priming the surface being coated. A coverage of 350 to 450 sq. ft. of area per gal. per coat is obtained when applied by brushing directly from the container.

The finish is said to be unaffected by all alkalies as well as by their salts and by most mineral acids. In addition, they are inert to alcohols, soaps, water, oxidants, food and

DREVER

VERTICAL STRIP ANNEALING FURNACES

improve

SILICON STEEL

production facilities

IN CARNEGIE-ILLINOIS VANDERGRIFT PLANT

Photo Courtesy of Carnegie-Illinois Steel Corp.

A complete line consists of two uncoilers for handling cold reduced coils; multiple seam welder; continuous strip cleaner; looping pit to secure accurate guiding and tensioning of strip through furnaces; 13 zone controlled atmosphere annealing furnace, with cooling tower, drive bridle for forwarding strip; guiding and controlled tensioning for recoiling; 2 recoilers. The coils come out absolutely square.

The coiled silicon steel from these two continuous furnace lines recently put in operation in this U. S. Steel Plant, is very flat from edge to edge. Users of this strip report excellent surface characteristics which tend to increase stamping die life.

Drever continuous annealing lines for Tin Plate, Galvanizing Stock, other Low Carbon Steel and Non-Ferrous Strip in capacities up to 30 tons per hour, provide an economical investment in tonnage production of quality material.

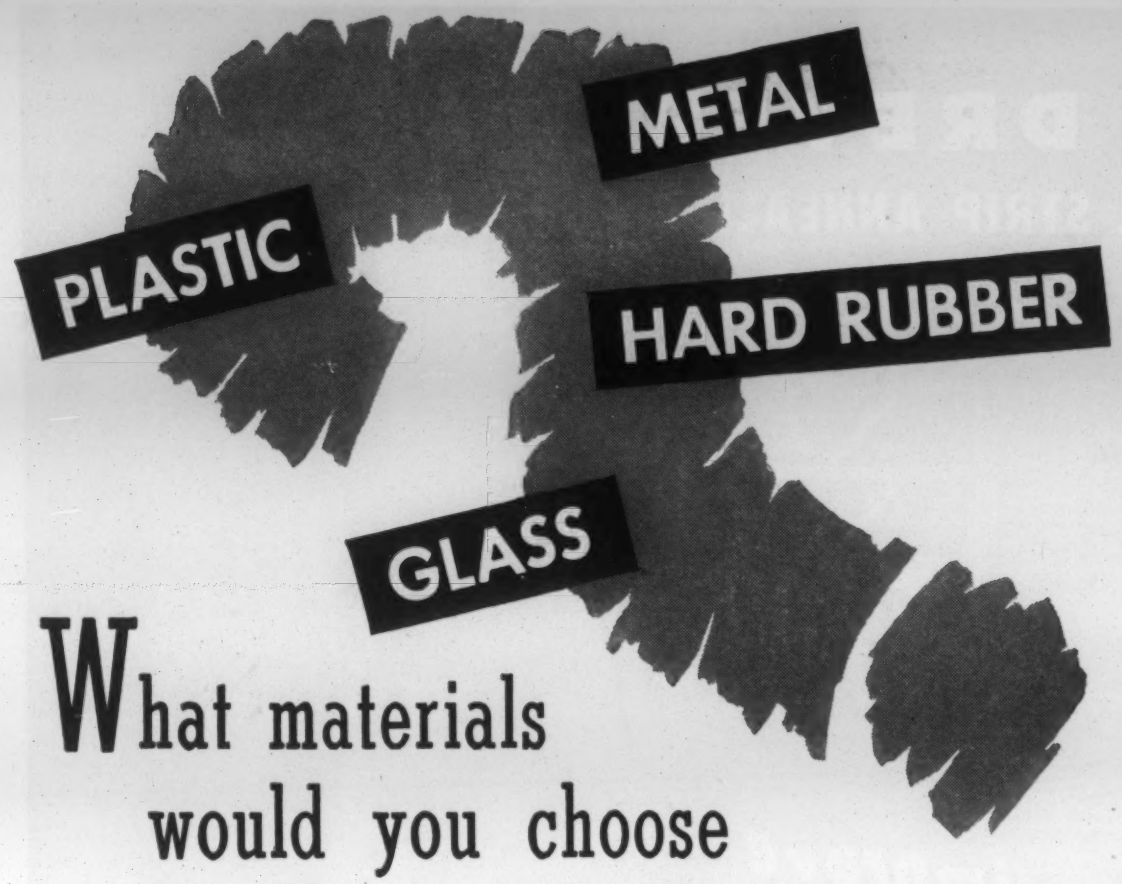
Detailed information upon request.

DREVER CO.

750 E. VENANGO ST., PHILA. 34, PENNA.

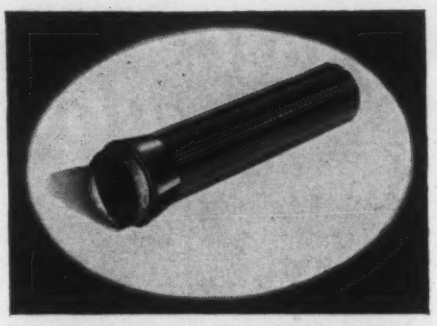
CONTINUOUS FURNACE LINES, HEAT TREATING FURNACES, DESCALING & ATMOSPHERE EQUIPMENT

NEW YORK & NEW ENGLAND—GERALD B. DUFF, 68 CLINTON AVE., NEWARK 5, N. J.
W. PENNA., W. N. Y. and OHIO—H. C. BOSTWICK, 3277 KENMORE RD., CLEVELAND 22, OHIO
IOWA, MINN. & WIS.—WALTER G. BARSTOW, 1302 FIFTH AVE. SOUTH, MINN. 4, MINN.

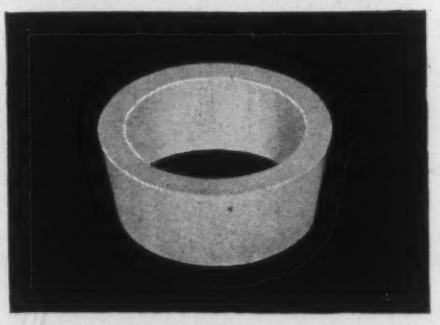


What materials would you choose for these parts?

1 INDUSTRIAL FLASHLIGHT CASE: Must be tough, good-grip, non-corrosive, oil-resistant surface. Should be electrically insulated. Plated, painted, imitation leather surfaces had been tried, but they corroded, chipped, or peeled. What material would *you* use?



2 Tapered gasket ring, exposed to acids, alkalies and essential oils, must impart no taste or odor to solutions. Must be free from "cold flow" for tight seal through a temperature range from 0° to 100° F. What material would *you* pick?



Answers: No. 1—Ace hard rubber, molded around brass tube, gives insulated, practically indestructible flashlight. No. 2—Ace Parian (polyethylene) is ideal for this gasket ring.

Yes, sometimes it's hard rubber, and sometimes it's one of the other plastics that's best. Ace, with many hard rubber and plastics compounds to choose from, is fully equipped to supply whatever you need. If you want this kind of impartial advice from your molder, select American Hard Rubber Company. Send for free 60-page Ace Handbook—a gold mine of helpful data.

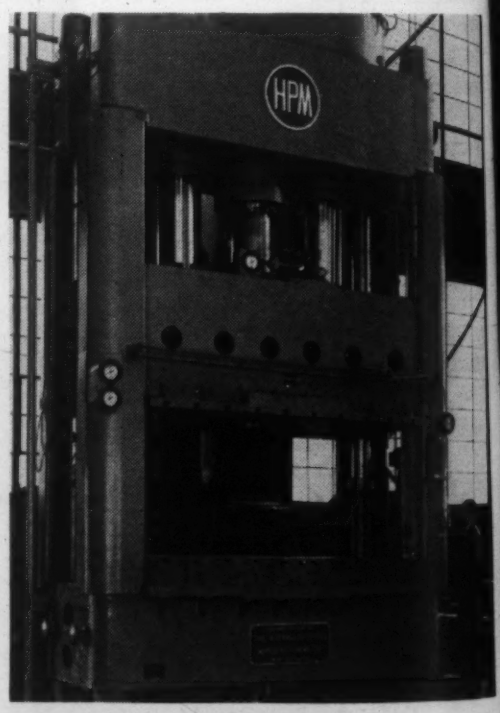
ACE
HARD RUBBER and OTHER IMPORTANT PLASTICS
AMERICAN HARD RUBBER COMPANY
Since 1851
11 MERCER STREET • NEW YORK 13, N. Y.

New Materials and Equipment

fruit acids, oils, aliphatic hydrocarbons gasoline (low octane), and many other corrosive reagents. They permanently maintain their flexibility over a wide range of temperatures and are recommended for services to 180 F.

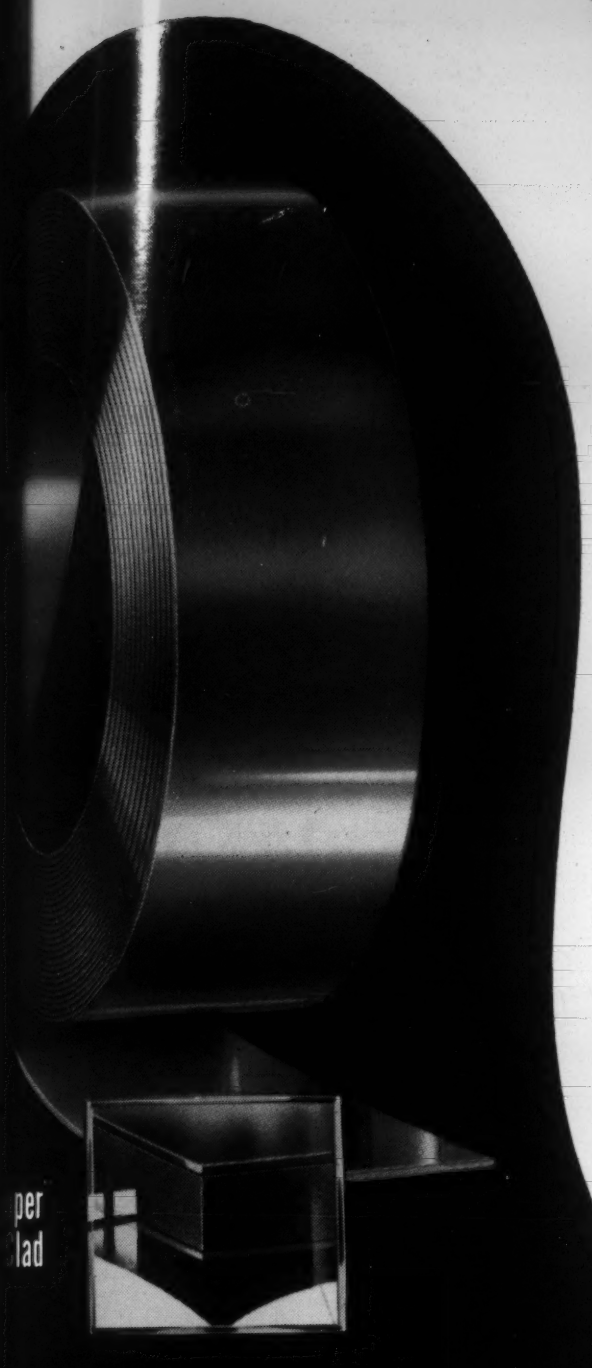
Sheet Metal Press for Deep Drawing Jobs

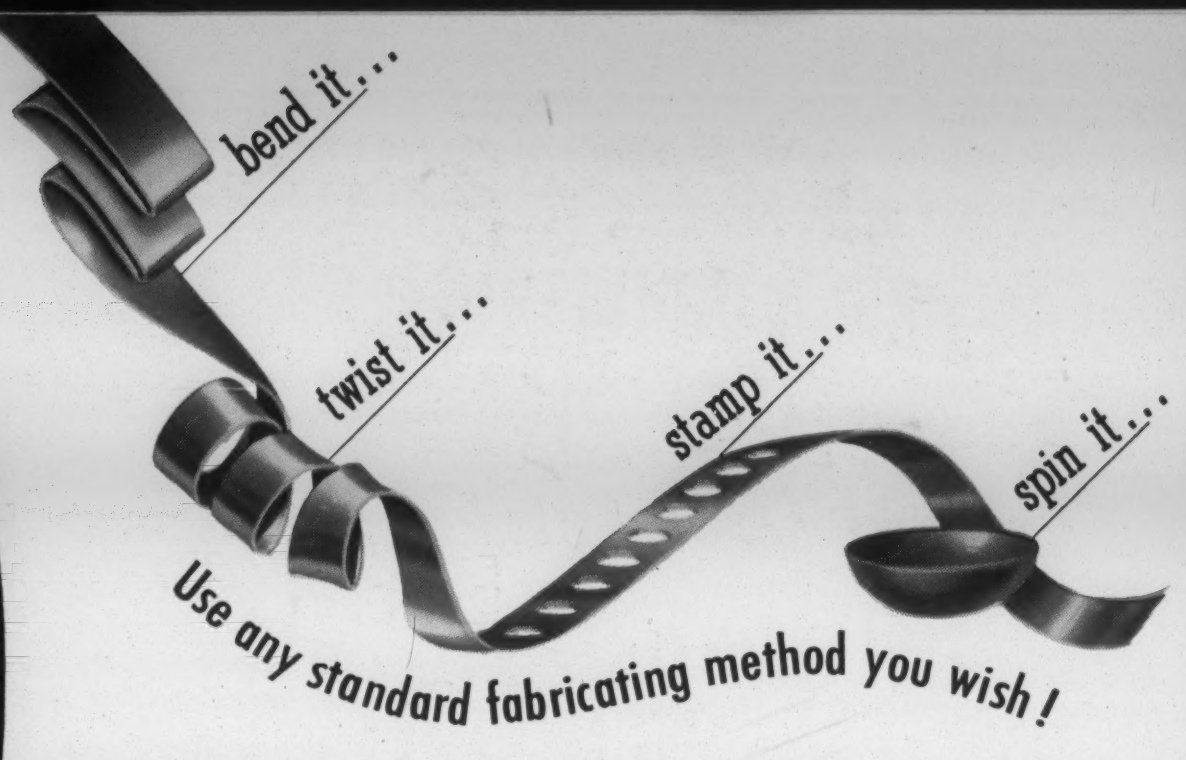
A sheet metal drawing press of 1000/500-ton pressure capacity has been designed by the *Hydraulic Press Manufacturing Co.*, Mt. Gilead, Ohio, to handle deep draw jobs of exceptionally large dimension. It has a platen of 120 by 72 by 70 in. daylight opening and 36-in. ram travel. It is equipped with a 300-ton hydraulic die cushion with a platen of 48 by 52 in. and a 24-in. stroke. The bolster plate is removable.



This press is equipped to operate in two ranges of pressing speed.

The press is equipped with three main rams for the multiple press ram system of operation in two ranges of pressing speed. For a fast preliminary pressing at medium pressure, either the central main ram or the two outer rams can be employed with a 500-ton pressure. At a predetermined position, all three rams can be used to develop the high pressure required for final forming. A typical example of how this works is





Use any standard fabricating method you wish!

The bond is inseparable!

SuVeneer Clad Metal's solid copper, monel or nickel cladding is bonded to low-carbon strip steel *for keeps!* It cannot be separated by mechanical means—you can use full freedom in new product design and count on dependable fabrication results. Get the special benefits of these solid metals combined with a strip steel base—specify and use *SuVeneer Clad Metal!*

SuVeneer®

CLAD METAL

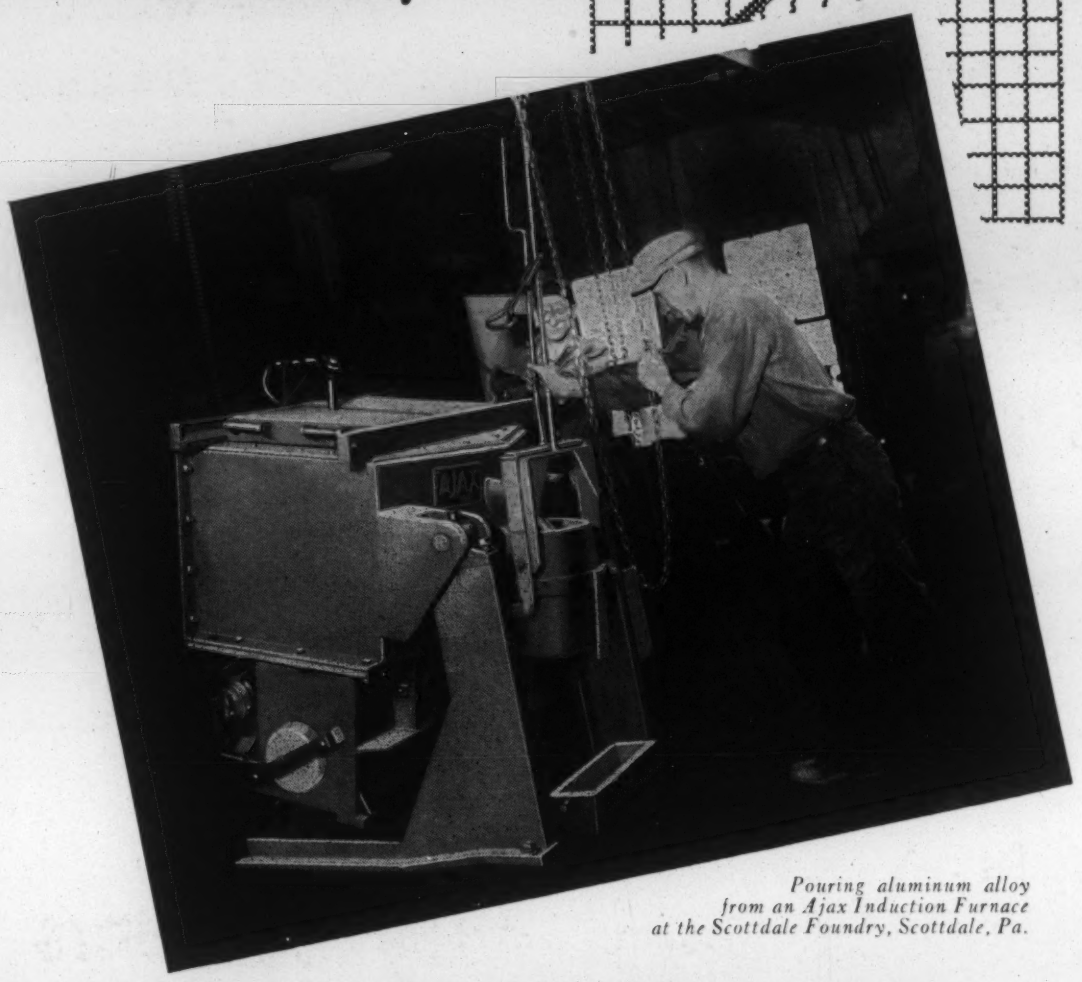
Monel Clad

Nickel Clad

Superior Steel
CORPORATION
CARNEGIE, PENNSYLVANIA

AJAX INDUCTION FURNACES

ARE KEPT BUSY PROVIDING ALUMINUM FOR *MILLIONS* OF CASTINGS!



Pouring aluminum alloy from an Ajax Induction Furnace at the Scottdale Foundry, Scottdale, Pa.

SUBSTANTIAL SAVINGS IN TIME, LABOR, METAL, AND FLOOR SPACE, PLUS HIGH COUNT OF PERFECT CASTINGS WITH AJAX ELECTRIC INDUCTION FURNACES

- No flux needed—no mechanical stirring—no segregation occurs, because metal is in constant circulation.
- Costs less than conventional combustion firing—avoids overheating as temperature control is completely automatic.
- Low upkeep—linings average two years of service—almost no down time—lower melting losses.
- Temperature held within ±5°F—metal kept at lowest feasible casting temperature—no danger of overheating.
- Harmful impurities removed—less dross—no iron pick-up—iron impurities adhere magnetically to passage walls.
- High yield of perfect castings—a remarkably low scrap loss, that is possible only with induction furnaces.
- No fumes—almost noiseless operation—cooler shops—lower installation and maintenance costs.
- Automatic electric controls require a minimum of attention—less labor than for fired furnaces.
- Requires 30% to 40% less floor space than any other type of induction furnace—heavy steel construction for long life.

AJAX ENGINEERING CORPORATION, Trenton 7, N. J.

AJAX TAMA-WYATT INDUCTION MELTING FURNACE

Associate Companies: AJAX METAL COMPANY, Non-Ferrous Ingot Metals and Alloys for Foundry Use
AJAX ELECTROTHERMIC CORP., Ajax Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax Wyatt Induction Furnaces for Melting

New Materials and Equipment

seen in the following speed variations. Where the 500-ton pressure is used, pressing speed drops to 28 in. per min.

The press is equipped with a system of operation which regulates both the speed and direction of every press ram movement through control of the output of the pressure-generating radial pump. The action results in fast travel of the ram to the work, a slower, controlled, smooth pressing speed, and the rapid return of the ram to neutral position once the desired pressure has been reached on the work. The cycle of operation is fully automatic and is controlled by electric pushbuttons located at the operator's station.

Glass Phenolic Laminate Has High Flexural and Impact Strength

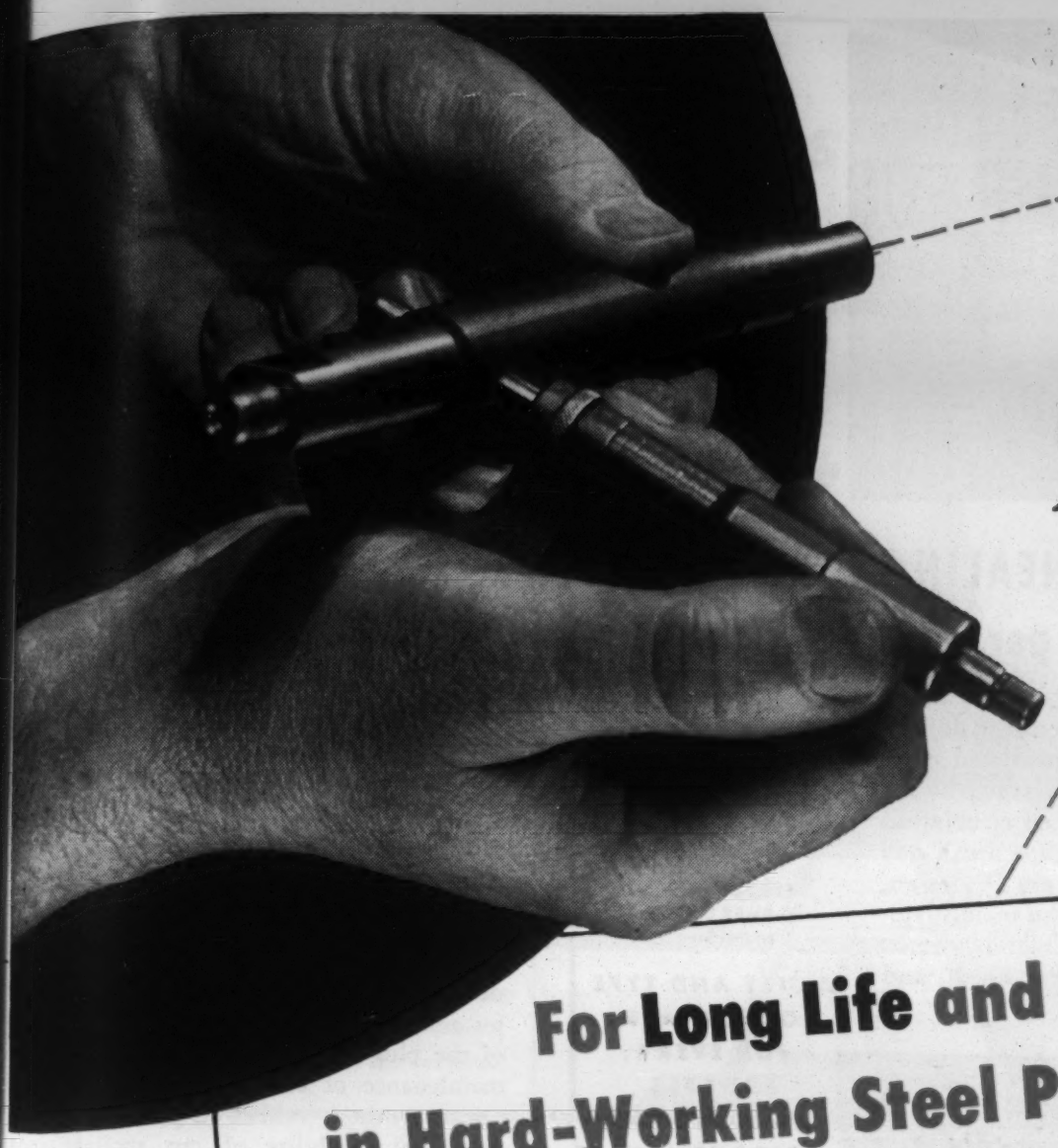
The production of a new glass phenolic laminate, known as Grade 170, has been announced by the *St. Regis Paper Co.*, Panelyte Div., 230 Park Ave., New York 17.

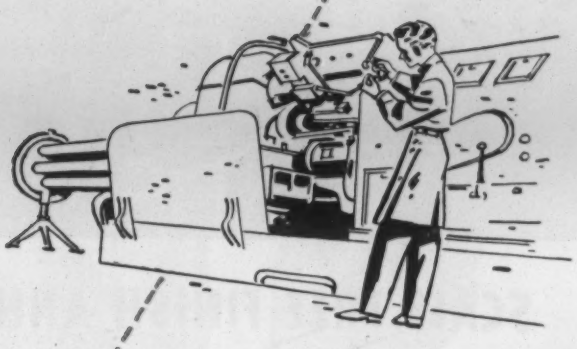
This glass laminate is said to be extremely low in water absorption with a value of 0.06%, low in power factor, and high in flexural and impact strength, as measured by ASTM methods.

Due to the very low water absorption and high strength, it is said that this grade may eliminate the necessity of anti-fungus treatments and other special handling now required for use in equipment in tropical climates and under high humidity conditions.

The laminate will be produced in standard sheet sizes of 36 by 36 in. and 36 by 48 in., natural color, semi-gloss finish, thicknesses ranging from 1/32nd to 2 in., with a standard NEMA tolerance for Grade G-3. The detailed properties of Grade 170 are listed below:

Tensile Strength—52,000 psi.
Flexural Strength—69,000 psi.
Bonding Strength—1900 psi.
Impact Strength—37 (flat), 18 (edge)
Density—1.78
Water Absorption—0.06%
Dielectric Strength—580
Power Factor—0.006
Dielectric Constant—4.45
Loss Factor—0.027





For Long Life and Low End Cost in Hard-Working Steel Parts . . .

. . . use *Republic* Cold Drawn Alloy Steel Bars

LONG LIFE—Because Republic Alloy Steels provide these long-proved advantages: (1) High strength to carry heavy loads; (2) Toughness to withstand severe shock and strain; (3) Uniform response to hardening treatment that produces hard bearing areas.

LOW END COST—(1) Because the long life of steel parts made of Republic Alloy Steels means fewer repairs and replacements—less maintenance expense—more operating time and less down-time. (2) Because these bars provide the UNIFORM MACHINABILITY, accuracy of section, close tolerances and fine surface finish for which Union Cold Drawn Products are so well known—and which means lowest possible parts production costs.

Republic Cold Drawn Alloy Steel Bars are available in all popular analyses, in standard shapes and sizes, furnace treated as you desire—annealed, normalized, spheroidized, stress relieved or carbon corrected. Republic metallurgists are ready to help you get the results you need. Write for further information.

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N.Y.

Republic COLD DRAWN
REPUBLIC STEEL
REG. U.S. PAT. OFF.
ALLOY STEEL BARS

Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Plates, Pipe, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

EF

GAS-FIRED
OIL-FIRED
and ELECTRIC
FURNACES
for

AGING
ANNEALING
BRAZING
CARBON RESTORATION
CARBURIZING
CERAMIC DECORATING
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MALLEABLIZING
NORMALIZING
NITRIDING
SINTERING
SOLUTION TREATING
SPECIAL ATMOSPHERE TREATMENTS

A SIZE AND TYPE OF FURNACE FOR EVERY PROCESS PRODUCT OR PRODUCTION

SCALE FREE FINISH ANNEALING
5000 lbs. of brass strip per hour

● The gas-fired roller hearth furnace pictured above is of EF's semi-continuous intermittent operating design, with separate chambers for preheat, anneal and cool. Special ratio controls produce the exact atmosphere desired, and an ingeniously designed forced circulation system assures a uniform anneal and surface finish day after day. Let us show you how EF research, EF design, and EF experience has greatly advanced the metallurgical processing of ferrous and non-ferrous metals, resulting in closer physical tolerances, uniform finish, and efficient, low cost, trouble-free operation

THE ELECTRIC FURNACE CO.
WILSON ST. AT PENNA. R.R. Salem-Ohio

THE PLACE TO SOLVE YOUR BOLT PROBLEMS

Brass
BOLTS·NUTS
STUDS

Brass and Bronze, all types — every non-ferrous metal — available in all standard dimensions or to your specifications.

SINCE 1882
Better Bolts of Brass, Steel, Iron and Other Metals.

USE HEADED AND THREADED FASTENERS FOR ECONOMY AND RELIABILITY

"THE BOLT MAN"

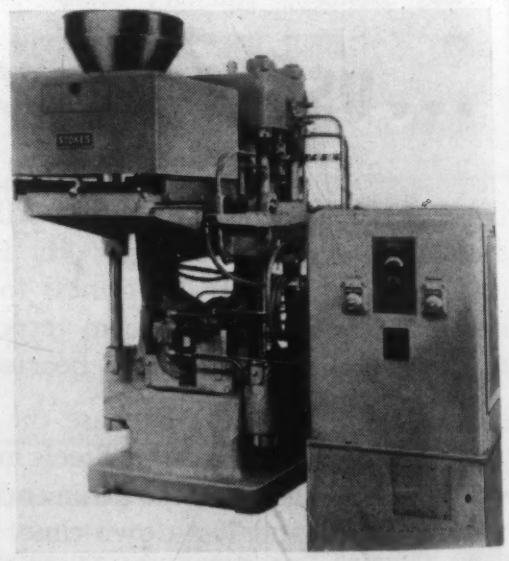
PAWTUCKET
MANUFACTURING COMPANY
327 Pine Street · Pawtucket, R. I.

New Materials and Equipment

New Presses Feature High Production Rates

Two new presses have been announced by the *F. J. Stokes Machine Co.*, 5972 Tabor Rd., Philadelphia 20. One of these is a redesign of the fully automatic 50- and 150-ton closure presses for producing closures or threaded parts in large quantities.

The new press requires only 15 sec. plus curing time to automatically load, close, open, unscrew, and eject closures. The new features include a redesigned die transfer and rack cylinder; electrical connections of the plug-in type, simplifying set-up and maintenance of electrical circuits; heat resistant synthetic rubber stripper bars eliminate the possibility of cap spoilage and assure positive removal of caps from the forces; stripper bars are positively aligned by a single adjustment; and an improved unscrewing mechanism. The press is designed to take a maximum mold or die



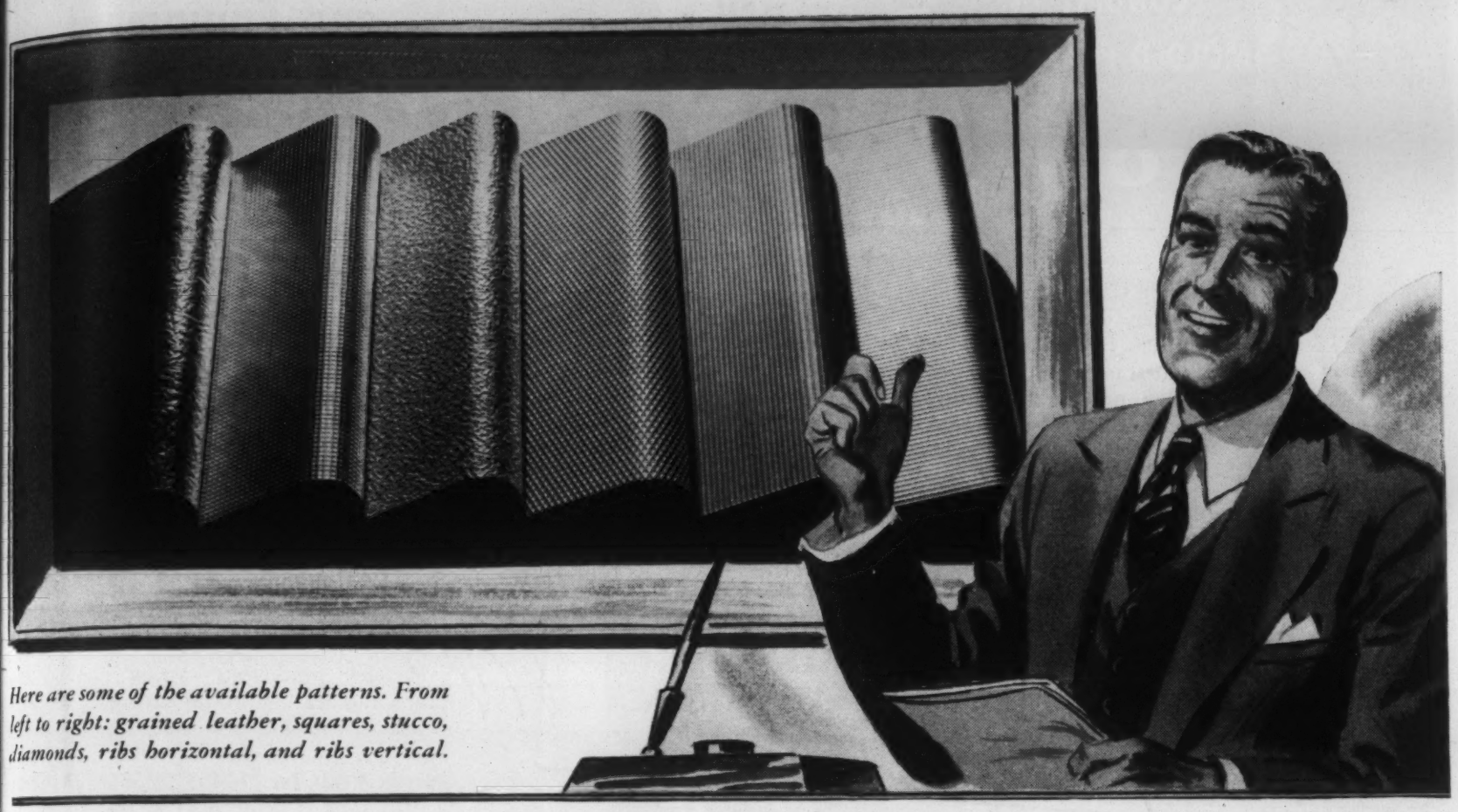
The closure press can produce 5400 24-mm. closures per hr.

area of 12 by 18½ or 19½ by 24 in. for the 150-ton model, and for either steam or electric heating.

The other new press is a 200-ton straight-ram type hydraulic semi-automatic plastics molding press which is suited for general purpose molding. Particularly, the press meets the demand for molding large parts having deep draws and heavy sections, such as radio cabinets, telephone bases and toaster bases.

Some of the features in this press include: automatic cycle control by bar-type controller; three-speed controlled closing; highly efficient low hydraulic pressure system;

THIS PHOTO OF FINISHES HAS STARTED A RACE



Here are some of the available patterns. From left to right: grained leather, squares, stucco, diamonds, ribs horizontal, and ribs vertical.

New Reynolds Embossed Aluminum Sheet Eliminates Surface Finishing

ANOTHER amazing development in aluminum from Reynolds! This time it's aluminum sheet with the new beauty of embossed finishes. Watch wise manufacturers rush to take advantage of this development, because it brings sweeping fabrication economies. Look for attractive new products, too, when designers get going with this new idea.

For example, an embossed finish offers you a partially fabricated product . . . provides big savings over involved finishing methods. And it's a better finish that adds new beauty. Scratches won't show, glare is cut, and you know aluminum won't rust. Embossing also affords selective stiffness or greater over-all rigidity, according to the pattern chosen. Embossed sheet can be drawn, formed, etched, or welded. Available now in quantities for development work.

The race has already started—manufacturers are using the patterns shown above for a host of better products . . . from panels on coin merchandising machines to truck body sections, and even for roofing. These users are also enjoying the other advantages of aluminum . . . such as three times the metal per pound to work with, less handling cost due to reduced weight, lower shipping cost. Aluminum is easier to work, faster on production lines. It offers smart new styling for products.

For information on this new embossed sheet and every kind of aluminum to economically improve your product, call your Reynolds Distributor or the nearest Reynolds Office, listed under "Aluminum" in the classified section of your telephone directory, or write to Reynolds Metals Company, Aluminum Division, 2560 South Third St., Louisville 1, Kentucky.

FINISHES FOR ALUMINUM
Send your request for this informative book on your company letterhead and receive your copy without charge.

IF YOU SEE RUST YOU KNOW IT'S NOT ALUMINUM

REYNOLDS METALS

REYNOLDS Lifetime ALUMINUM

REYNOLDS PIONEERING MADE ALUMINUM COMPETITIVE . . . TAKE ADVANTAGE OF IT!

WANT TRUE ECONOMY IN MOLDED PLASTICS?

There are so many plastics, so many design factors, so many angles involved in choosing from among the different molding methods that it pays to get the best, most experienced help with your custom molding jobs.

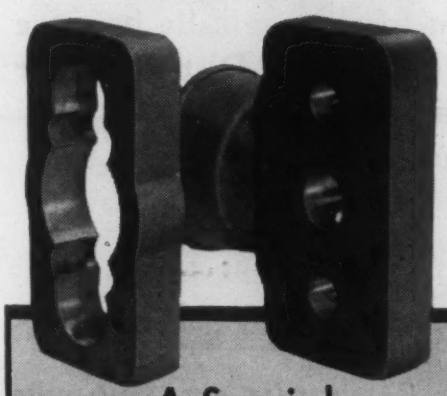
This help is available from the Watertown man virtually on your doorstep. He's backed by our 34 years experience and complete facilities, including a laboratory second to none in the industry, to develop, produce and test your part or product to your satisfaction . . . and your customers'.

If you have a custom molded plastics job on blueprints . . . or merely in mind . . . phone your nearest Watertown man today . . . or phone or write us directly. Here are the Watertown men . . .

New York—H. A. Rankow, 175 Fifth Ave.
Chicago—National Insulations Co.,
2808 W. Lake St.
G. W. Glaescher
J. P. Bonnamy
R. C. Farquhar
J. R. Kallaher
J. P. Greener
Detroit—J. P. Greener from Chicago
Cleveland—Carl F. Linn, 866 Hanna Bldg.
Milwaukee—Roger L. Miller, 729 N. Broadway
Seattle—John W. Witherow, National Vulcanized Fibre Co. 1927 First Ave., South
San Francisco—G. W. Harmssen, National Vulcanized Fibre Co. 273 Seventh Ave.
Los Angeles—Fred M. Foley, National Vulcanized Fibre Co. 2325 East Eighth St.

THE WATERTOWN MANUFACTURING CO.
600 ECHO LAKE RD., WATERTOWN, CONN.

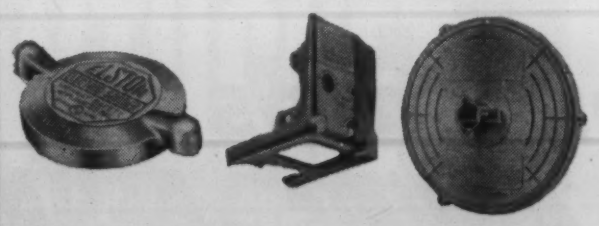
ALUMINUM DIE CASTINGS
by
Char-Lynn



A Special Char-Lynn Process die-casts these heavy-section castings WITHOUT POROSITY!

Even complex shapes can be economically produced by Char-Lynn methods. Careful handling reduces the number of operations in machining and assembling. Production retains exact shapes and dimensions and is delivered with good surface finishes. *Capacity up to 6 pounds.*

Write or phone for engineering consultation and estimates



Char-Lynn Company
2875 26TH AVENUE SOUTH • DUPONT 235
MINNEAPOLIS 6, MINNESOTA

New Materials and Equipment

adaptable return stroke; simple, easy-to-operate electrical and hydraulic controls; compactness, requiring minimum floor space; easy installation; and ready conversion to plunger molding.

Continuous Casting Method Produces Dense Bearing Bronze

A new continuous casting method of producing bearing bronze having 83 copper, 7 lead, 7 tin and 3% zinc, meeting SAE 660 specification, has been developed by *Ampco Metal, Inc.*, 17455 38 St., Milwaukee 4, Wis., and is being used by the American Smelting & Refining Co.

The bearing bronze, known as Asarcon 773, is supplied in standard sizes ranging from ½ in. dia. up to 4¼ in. in solids, and 1-in. OD by ½-in. ID to 4¼-in. OD by 3¼-in. ID in hollow bars. Lengths are not standard, but distributors will cut any diameter to the length required by his customer.

The bronze is said to have an extremely dense, small, even grain structure which eliminates a majority of the costly machining difficulties encountered in other methods employed to produce to this specification. It is free of porosity, dross or sand inclusions.

Dryer Designed for Use on Polished Metal Parts

A new mechanical dryer for the drying of metal parts has been announced by the *Optimus Equipment Co.*, 203 Water St., Matawan, N. J. The dryer was originally designed to meet the needs of the plating industry for the drying of highly polished metal surfaces without water spots, stains or streaking. Since then, these new dryers have been adopted for all types of drying of metal parts handled on monorail systems.

The dryers are designed to handle the drying of metal parts either on racks or monorail on a continuous production basis. They provide spotless drying after plating or polishing and before subsequent plating or lacquering.

High velocity jet nozzles are specially

Steel-Weld FABRICATION

As these heavy press frames attest, Steel-Weld Fabrication has been developed to a fine art by Mahon craftsmen . . . this is true of any type of welded steel base, frame, or heavy machinery part produced in the Mahon plant, regardless of size, shape or weight. The Mahon organization is also fully equipped to handle heavy machine work of all types up to unusual dimensions. These facilities and highly skilled craftsmen, backed by a staff of design engineering experts, assure you of a source which will produce for you a better, smoother appearing job, embodying every advantage of Steel-Weld Fabrication.

THE R. C. MAHON COMPANY
Detroit 11, Michigan

Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

MAHON

TITANIUM

★ HYDRIDES

★ MASTER ALLOYS

★ ALLOY POWDERS

★ IN FORMS FOR LADLE ADDITIONS

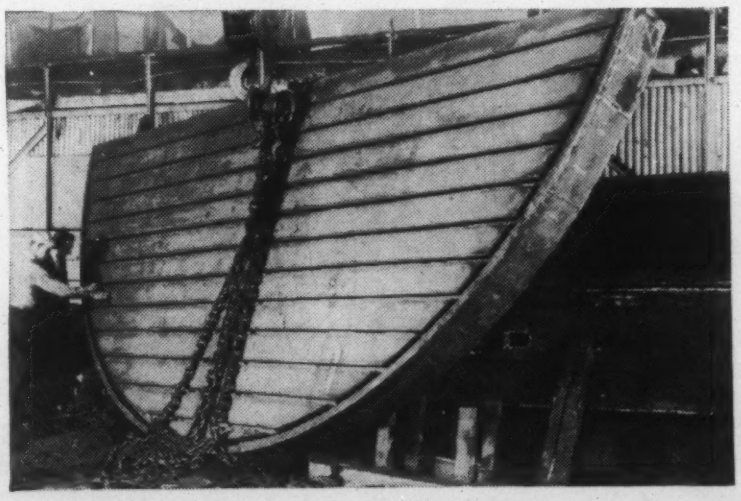
Inquiries Solicited

METAL HYDRIDES INC.

FACTORY AND SALES OFFICES, 12-24 CONGRESS ST., BEVERLY, MASS.

4-MH-1

SAVINGS START IN THE FOUNDRY



This Advance casting weighs 37,000 lbs. It is a half-round base for a big radial drill. The diameter is 23 ft. Our customer passed many nearer foundries to give the job to us.

It is a rather large undertaking to mold and pour an 18½-ton casting. The job is all the more serious when the casting is a radial drill base with the entire top surface, the rim, and approximately 190 ft. of T-slots to be machined. Such a casting has to be right in every respect to avoid excessive machine-shop cost.

In our founding of *Strenes Metal* cast dies, we have exercised the greatest care to produce sound, accurate, predictable castings. The same techniques are employed on our gray iron and alloy castings which require precise machining. That's why we are doing jobbing work for customers hundreds of miles from Dayton. The freight is insignificant compared to the savings in machining cost.

If you have been getting castings which involve welding or repairing because of blowholes, cold shuts, cracks, sponginess, etc., it will pay you to consult with us. Write, wire, or phone for complete information.

THE ADVANCE FOUNDRY CO.

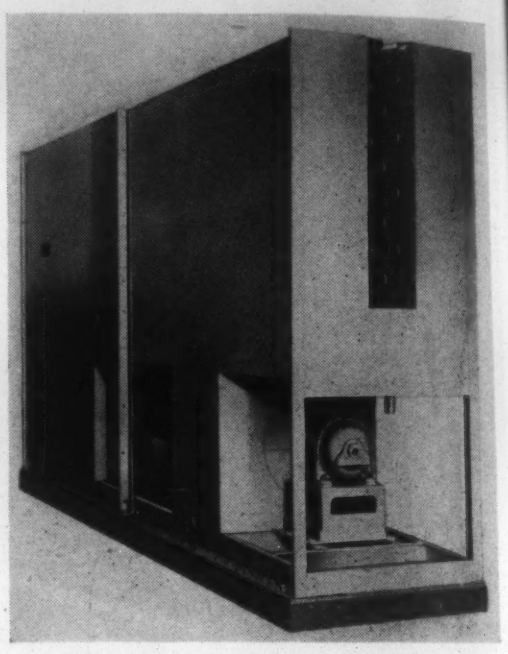
DAYTON 3, OHIO

ADVANCE CASTINGS

STRENES METAL • ALLOY GRAY IRON • GRAY IRON

New Materials and Equipment

designed to be both directional and adjustable. Combinations of cold and hot air drying are employed. Cold blast removes water by mechanical action, leaving a film which is removed by the following hot air



This dryer features directional and adjustable jet nozzles.

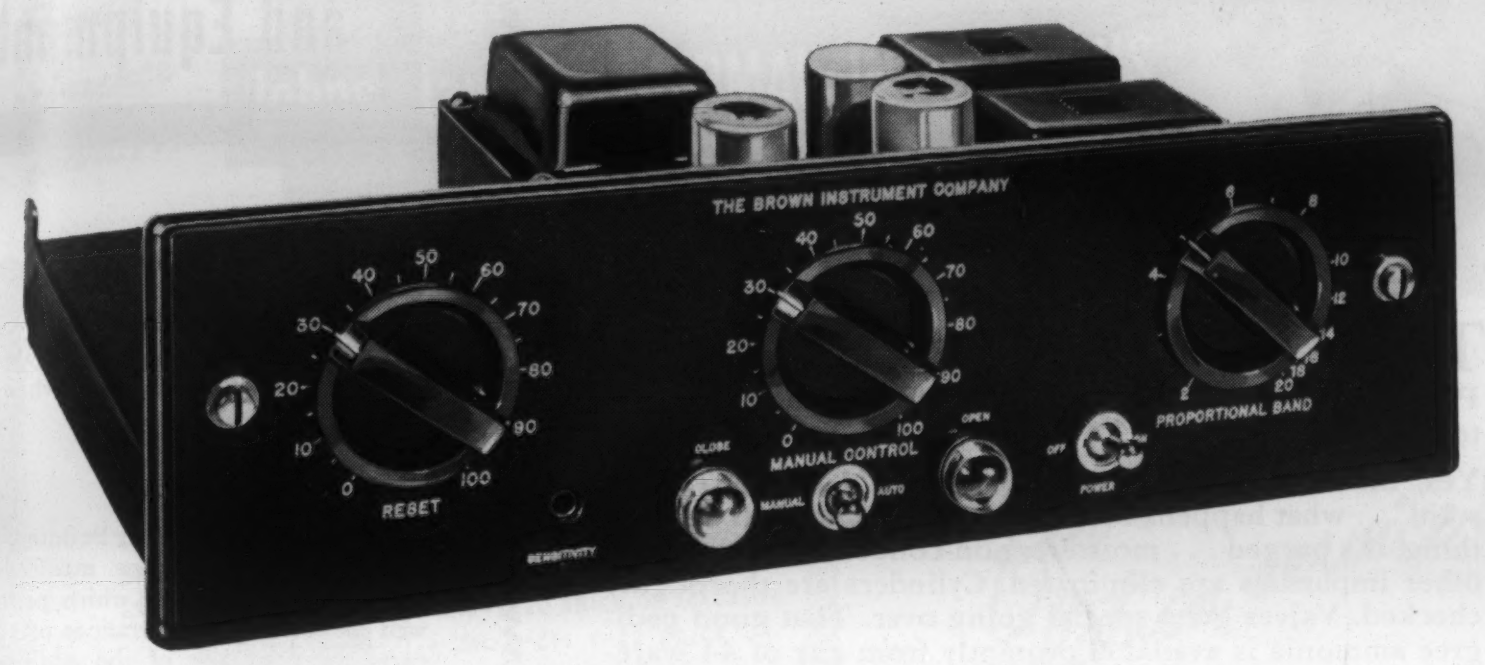
blast. Provisions are made to recirculate all possible heated air.

These dryers require a minimum of floor space, and where overhead space permits, the units can be suspended from the ceiling. Air for drying can be heated by steam, gas or electricity.

High-Viscosity, Low-Pressure Resin Developed

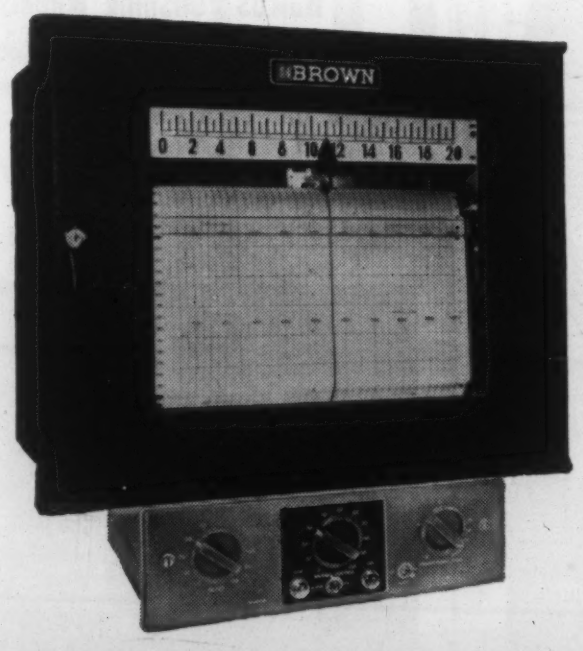
A new low-pressure resin with a viscosity of 50,000 to 65,000 centipoises is now available in commercial quantities for plastics laminating, molding or casting operations from the *Resinous Products Div., Rohm & Haas Co.,* Philadelphia, Pa. Its suggested uses: to improve laminating work by a thicker surface coating; to decrease the flow of resin prior to gelation in molding; to improve control of pigment and filler suspension in casting operations; or to increase film thickness of dip coatings.

The new resin has been designated as P-43HV, and is identical to the Paraplex P-43 except that it is supplied at a polyester styrene ratio of 80:20 instead of 70:30. Its high viscosity compares with that of



Picture OF A "PLUS"

...In Proportioning Control



Brown *electronic proportional control relay* (shown with cover door in phantom) with the *ElectroniK* Strip Chart Controller. It may also be used with the *ElectroniK* Circular Chart Controller . . . and is available for new or existing proportioning control installations.

Here's a "plus" that you can see and evaluate in terms of better production at lower cost. It's the new Brown *electronic proportional control relay* . . . the relay that permits you to take full advantage of the extreme sensitivity of your *ElectroniK* Controller.

The extra features of this new, compact unit include unmatched sensitivity and stability, positive action, manual reset adjustment, signal lights to indicate valve operation, and an adjustment of 24% to 206% of the nominal proportional band value of the instrument resistor. Designed for flush mounting, its drawer-type construction makes it easily accessible.

All of these features add up to a big "plus" in proportioning control that deals in dollar and cents results. Write, today, for Specification Sheet #193 . . . or call your local Brown engineer for free consultation and advice.

MINNEAPOLIS-HONEYWELL REGULATOR CO.

BROWN INSTRUMENTS DIVISION

4517 Wayne Ave., Philadelphia 44, Pa.

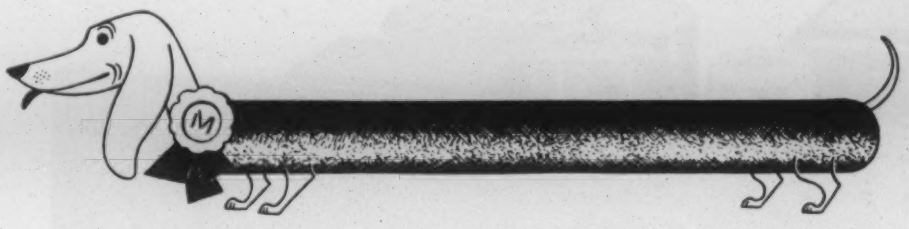
Offices in principal cities of the United States, Canada and throughout the world

MINNEAPOLIS Honeywell

Advanced Instrumentation FOR METAL PROCESSING

BROWN INSTRUMENTS

PURITY WITH A PEDIGREE!



THE forebears of Mathieson Ammonia are "blue-ribbon" quality . . . Mathieson sees to that. Mama Hydrogen and Papa Nitrogen are pure-bred—completely free from every trace of contamination.

Yes, Mathieson Ammonia has an enviable pedigree, but wait! . . . what happens before it reaches you? Well, for one thing, it's purged . . . moisture, non-condensable gases and other impurities are eliminated. Cylinders are thoroughly checked. Valves get a special going over. That good pedigree ammonia is available promptly from any of 44 warehouses. Write for free 40-page booklet: "Ammonia in Metal Treating". Mathieson Chemical Corporation, 60 East 42nd Street, New York 17, N. Y.

Ammonia, Anhydrous & Aqua . . . Caustic Soda Soda Ash . . . Bicarbonate of Soda . . . Liquid Chlorine . . . Dry Ice . . . Chlorine Dioxide . . . HTH Products . . . Fused Alkali Products . . . Sodium Chlorite Products . . . Carbonic Gas . . . Sodium Methylate

Mathieson AMMONIA

higher production starts with

PQ SOLUBLE SILICATES

Want to be surer of chemically clean metals prior to plating? Rely on the cleaning action of PQ Soluble Silicates, due to alkaline power as well as soluble silica. This exerts a special effect, usually available only in more expensive materials, i.e., it prevents removed dirt from re-depositing on clean metal.

For better results, for increased production, specify PQ Silicates in your cleaners. Ask for free copy of "Effect of Alkaline Detergents upon Metals."

PHILADELPHIA QUARTZ COMPANY
1133 Public Ledger Bldg., Phila. 6, Pa.

PQ SILICATES FOR FABRICATING METAL CLEANERS

Metso Granular
($Na_2SiO_3.5H_2O$) Sodium Metasilicate. Free-flowing, white granular product.

Metso 99
($Na_3HSiO_4.5H_2O$) Sodium Sesquisilicate. White, granular, free-flowing.

GC
($Na_2O.2SiO_2$) Powdered Sodium Silicate. Hydrated, alkaline. Readily soluble.

SS-C-Pwd
($Na_2O.2SiO_2$) Anhydrous Silicate. Slowly soluble. Ground to pass 65 mesh.

Sodium Sesquisilicate U. S. Pat. 1948730, 2145749 • Sodium Metasilicate U. S. Pat. 1898707

New Materials and Equipment

2000 to 2400 centipoises for the Paraplex P-43.

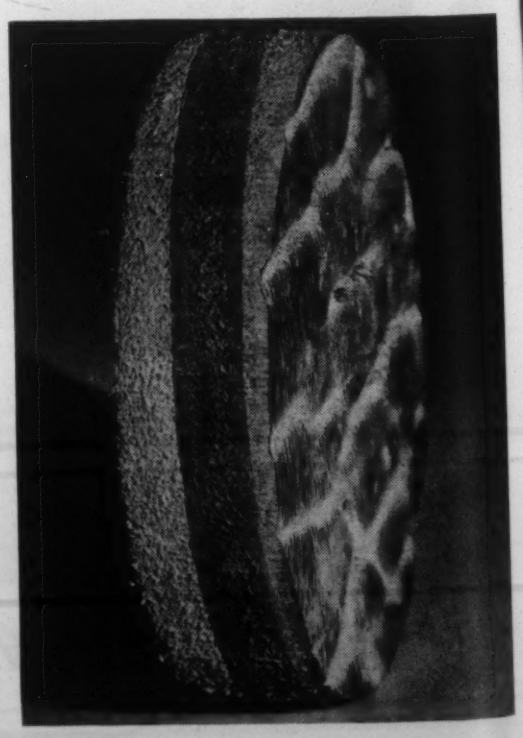
Both grades use the same base polyester, and both are filtered products, supplied as a sparkling clear, nearly water-white liquid.

● *Lubricants, Inc.*, Fisher Building, Detroit 2, has introduced a new modified sulfur chloride fatty derivative which performs as well in water at concentrations of 10 or 20 parts water to one of the additive. The material will not harm workman's skin or cause infection. Neither will it become rancid, cause stain, or corrosion, and it will remain stable upon long storage. It may be adapted to the machining of all SAE steels, particularly threading, tapping, broaching, horizontal or vertical, of Monel metal, chromium, chromium molybdenum, chromium nickel, tungsten, and the stainless steels.

Scratching Eliminated by Wedge-Layer Walrus Polishing Wheels

Walrus hide polishing wheels of wedge-layer structure that are said to eliminate abrasive injury in fine finishing, together with solid walrus hide polishing wheels, have been introduced by *Greene, Tweed & Co.*, North Wales, Pa.

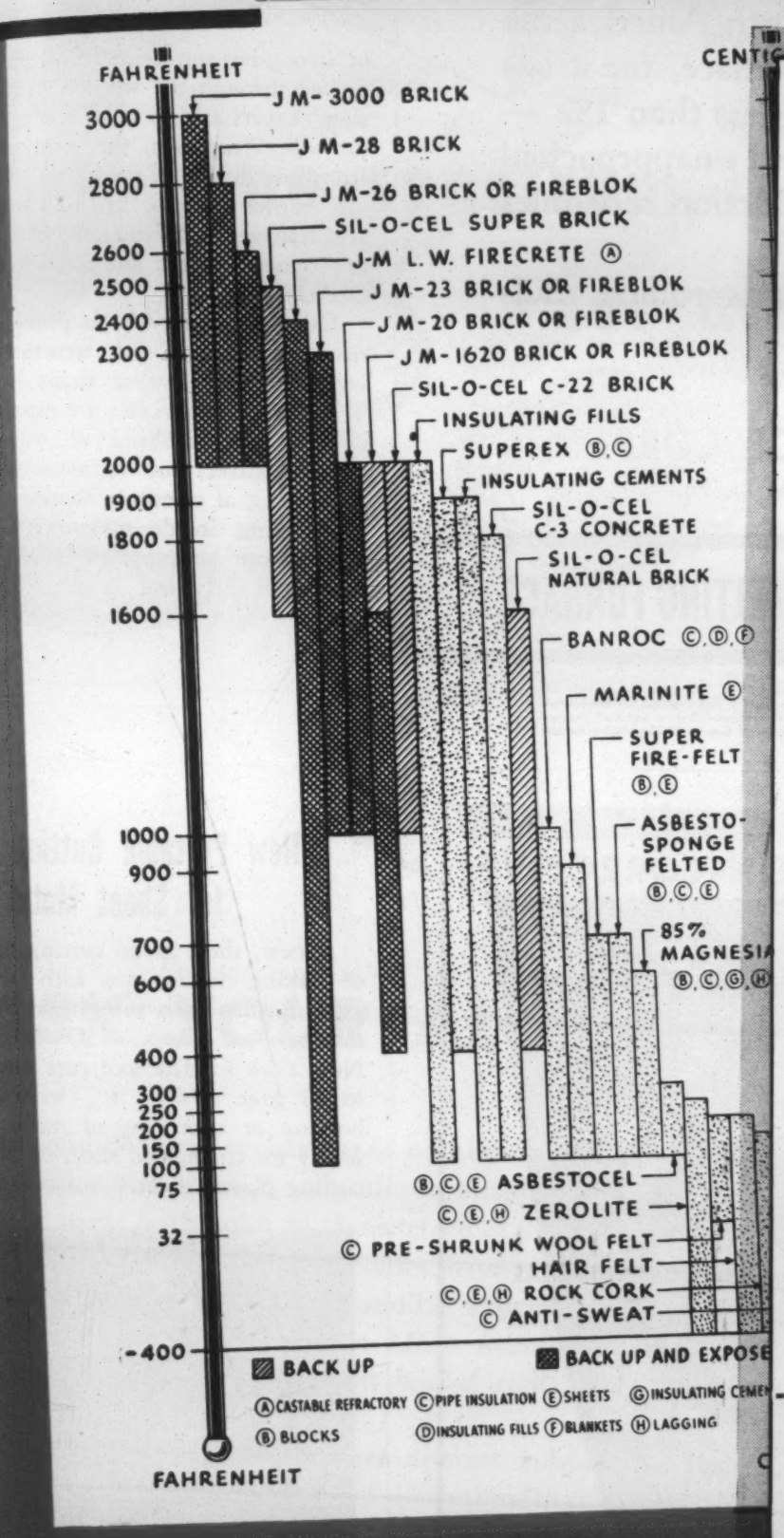
Surface scratch is minimized by the use



End view of walrus hide polishing wheels showing wedge-layer structure.

Ready reference chart...

Johns-Manville THERMAL INSULATIONS



FOR EVERY TEMPERATURE JM EVERY

For further information write your nearest J-M office or Johns-Manville, 22

Yours... for better insulation service!

Now, you can see at a glance the recommended insulation for every temperature range, from minus 400F to plus 3000F.

It's all on this convenient Johns-Manville Thermal Insulation Chart (11½" x 18") available for hanging in your office or on your plant wall.

Each insulation in this group of Johns-Manville products is tailor-made to do a specific type of job *best.* And, as part of the Johns-Manville Insulation Service, specialists are available to help you with present insulation problems . . . or with those connected with future plans.

By having these men select and apply Johns-Manville insulations, you will be dealing with men who have grown up in the business. You'll find that it will pay, in the long run, to have these experts help you... *because they have to their credit more man-hours of insulation application experience than all other similar types of organizations combined.*

For your copy of this chart, just fill in and mail the coupon below.

Johns-Manville
Box 290
New York 16, N. Y.

Please send me copy of Johns-Manville Insulation Chart IN-6D.

Name_____

Title_____

Company_____

Address_____

City_____ State_____

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field — less than 1% — with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

The accepted melting tool in brass rolling mills throughout the world.

* *Upwards of 5 billion pounds annually.*

AJAX ELECTRIC FURNACE CORP.

1108 Frankford Avenue • Philadelphia 25, Pa.

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES:
AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup High Frequency Induction Furnaces*
AJAX ELECTRIC COMPANY, INC., *The Ajax-Hultgren Electric Salt Bath Furnace*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*

MAKE YOUR PRODUCT FULLY NON-CORROSIVE!

STAINLESS STEEL SCREWS

IMMEDIATE DELIVERY

Machine, Self-tapping Socket, Set, Wood Screws. Also Nuts, Bolts, Washers, Rivets, Pins—all types and sizes — delivered immediately from America's largest stock.

PROMPT SHIPMENT ON SPECIALS

For Catalog No. 49E, write today, on your letterhead.

MANUFACTURERS SINCE 1929

ALLMETAL Screw Products Co., Inc.

33 GREENE STREET, NEW YORK 13, N. Y.

New Materials and Equipment

of strong-but-soft cement; all scratch is re- moved through the wheel's wedge-layer de- sign. Layers are set at an angle; thus, whe the wheel revolves, the joint areas weav from side to side of the wheel. This enable the leather to pick up and wipe off an area transversed by the joint areas, removin any cement scratch and smoothing the sur face clean.

Design of these wheels provides an addi tional advantage, for structure of thin layered walrus leather strips is permitted These polishing wheels are especially adapt able to the finishing of copper, nickel German silver, and stainless steels; to the burnishing of unevenly shaped objects; and to working inside wide-mouthed objects. Wheels can be supplied in all thicknesses up to and including 7/8 in.

New Portable Cutting Tool for Sheet Metal

A new, sheet metal cutting tool, capable of making circular cuts with radii as small as 1 in., has been introduced by the *Nord International Corp.*, 130 Greenwich St., New York 6. The tool cuts sheet metal up to 20 gage (0.040 in.) without bending, burring or stretching of metal. It is also handy for corrugated sheet or pipe, and for cutting plastic sheet.

This sheet metal cutting tool is also useful for plastics.

The cutter is small, weighs 13 oz., and is portable and easily attached. It can be fixed in the chuck of any 1/4-h.p. motor in the same manner as a drill. The unit consists of seven simple parts, any of which can be replaced at comparatively little cost.

ASK YOUR ALUMILITE FINISHER

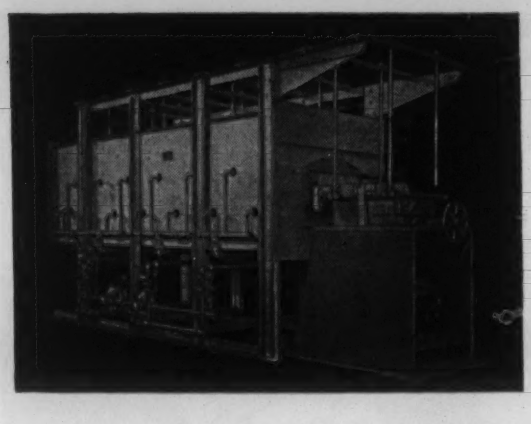
Automobile interior hardware of aluminum in any color you want . . . aluminum business machine parts with color in the surface . . . aluminum pencils and pens in colors from gold to black . . . the patented Alumilite Process lets you design your products in Alcoa Aluminum, then get the color you want sealed right *into* the finish.

Alumilite colors last longer against rubbing and abrasion, have a beautiful combination of color and metallic lustre that can be had on no other material than aluminum. If you prefer the silvery color of aluminum . . . and many people do . . . you can have the natural Alumilite finish, in a variety of textures and tones, that adds years of service to aluminum pieces and prevents smudging.

Ask your nearby Alumilite finisher to show you what has been done with Alumilite finishes on Alcoa Aluminum. You'll pick up some ideas. If you don't know your local Alumilite licensee, ask us for his name. Write to ALUMINUM COMPANY OF AMERICA, 662 Gulf Building, Pittsburgh 19, Pa. Sales offices in 55 leading cities.

ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM



RECIPROCATING, CONTROLLED ATMOSPHERE FURNACES

CONTINUOUS FURNACES SUITED TO WIDE RANGE OF GENERAL AND ATMOSPHERE WORK

VERSATILITY is an outstanding characteristic of A.G.F. Reciprocating Furnaces, which are suited to continuous clean hardening, annealing, normalizing, case-hardening by the patented Ni-Carb process, and many other types of work.

AMONG USERS are manufacturers of bearings, screws, lock washers, tools, wrenches, flat and coil springs, steel writing pens, and many others. Commercial heat treaters especially favor Reciprocating Furnaces because they are able to handle the many varied and different jobs daily received in a general heat-treating shop.

THE RECIPROCATING MUFFLE advances work through the heat by its own momentum. The complete elimination of conveying mechanism from the heating chamber reduces maintenance problems and heat losses to a minimum. There is no traveling belt to be alternately heated and cooled—only work enters and leaves the furnace.

MANUFACTURED IN FIVE SIZES, Reciprocating Furnaces have capacities ranging from 10 to 1200 pounds of work per hour. Write for detailed literature on these furnaces and other types of heat-treating equipment.

AMERICAN GAS FURNACE CO.
142 SPRING ST., ELIZABETH, N. J.

EBONOL
blackening processes

FOR STEEL . . . COPPER . . . BRASS . . . ZINC

EBONOL-C. (U. S. Patent 2,364,993) This is the best method of blackening and coloring copper and its alloys. Durable black cupric oxide is produced in a simple solution. Any metal that can be copper plated can also take this finish.

EBONOL-S. A one-bath method of blackening steel. Temperature 285 to 290° F. Simple to use and pleasant to run.

EBONOL-Z. A simple process for blackening zinc plate and zinc base diecastings. Beautiful glossy or dull finishes are achieved at low cost and trouble-free operation.

NEW TUMBLING TECHNIQUES are available for blackening and coloring. Send samples for free finishing demonstrations together with advice of experienced research chemists. **Write for new literature with procedures.**

ENTHONE INC. • 442 Elm Street, New Haven, Conn.

New Materials and Equipment

Band Saw With Spiral Blade Cuts Metals and Plastics

Intricate cuts can be made cleanly an easily in such widely different materials steel, plastic and foam rubber with a ne power band saw with spiral blade, a produ of the *Tyler Manufacturing Co.*, 6151 W 98 St., Los Angeles 45, Calif. This is mad possible by its spiral blade and by its uniqu planetary transmission.

The blade presents a 360-deg. cuttin edge that cuts smoothly in any direction The infinite speeds planetary transmissio provides a saw speed range of from 70 f per min. for steel and other tough meta to 5000 ft. per min. for wood, aluminum and other light materials.

The fact that the band saw with i spiral blade will cut freely in any direction results in many distinct advantages. It en ables the operator to cut any pattern with out turning the work. This means that h can saw to the center of any material 24 in wide and of any lengths.

The band saw will cut the followin materials: steel, iron, wood, plastics, bronze aluminum, wire, plywood, leather, tin, lin oleum, bamboo, felt, bakelite, nails, ma sonite, glass, gold, silver, fiber glass, cork foam rubber, wall board, balsa wood, as bestos, cardboard, and screening. A hard ened blade (81 Rockwell hardness) i recommended when the saw is cutting metal, the regular tempered spring stee blade for wood and other soft materials

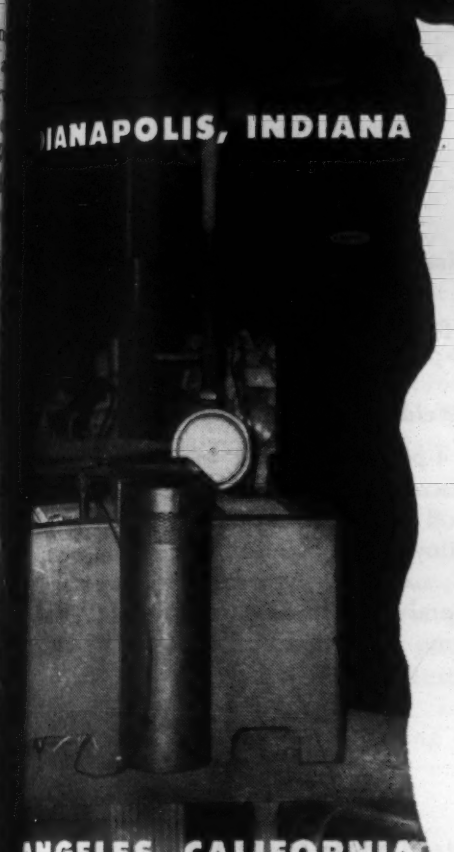
Inert-Gas-Shielded Arc Unit for Spot Welding

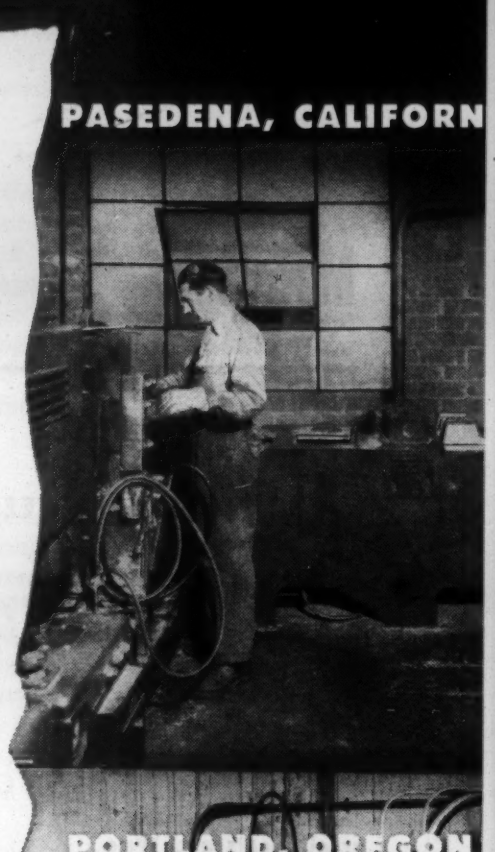
A new model welder-timer assembly for inert-gas-shielded arc spot welding has been announced by the *Miller Electric Manufacturing Co.*, Appleton, Wis. The arc welder consists of a pneumatic timer with solenoid gas valve and flow meter assembled to this company's Model 264 a.c. arc welder. It features continuous current control, with adjustment to the fraction of an ampere by rotating the control crank.

The high frequency unit and an extra heavy primary contactor with 110 v. operating coil are built in. The welder is provided with 220/440 v. primary connections. Power factor correction to give the unit a higher power factor and reduce the KVA demand load and primary ampere input is available as optional equipment.

The pneumatic timer is wired directly to the arc welder, requiring outside connections only to input power, gas, water, ground cable and the welding torch. The time in cycles to be used is selected by adjusting a control, easily accessible through a door in the side of the timer case.

(More News on page 132)





a REVOLUTION
IN DIE CASTING!

New Lindberg-Fisher 2 Chamber Melting Furnace revolutionizes die casting methods. Typical users throughout the country say:

Floyd J. Kamin, President, Kamin Die Casting & Mfg. Co., says: "On this job our new Lindberg-Fisher Induction Melting Furnace turns out twice as much work as a conventional gas furnace with the same melting capacity—and rejects have decreased 65%. We operate continuously, and we find that cost is actually less than with a gas furnace of the same melting capacity."

Edward L. Kornayzer, Kamin Plant Supt., says: "The furnace operates much cooler and operator fatigue is practically eliminated."

Roe F. Reed, President, Reed Metal Crafts, says: "We're more than satisfied with our Lindberg-Fisher melting furnace. We've ordered another and plan to install more in the future."

The Chief Engineer of a well known Chicago manufacturer of aluminum and zinc die cast products says: "Working conditions for our operators have been greatly improved because of lower temperature in the immediate area of the furnace. Furnace shell is so cool that you can touch it with bare hands. We also find that molten metal is noticeably cleaner and dross loss is considerably reduced.

Here are some of the many reasons why *you, too,* will want a Lindberg-Fisher 2 Chamber melting furnace in your plant . . .

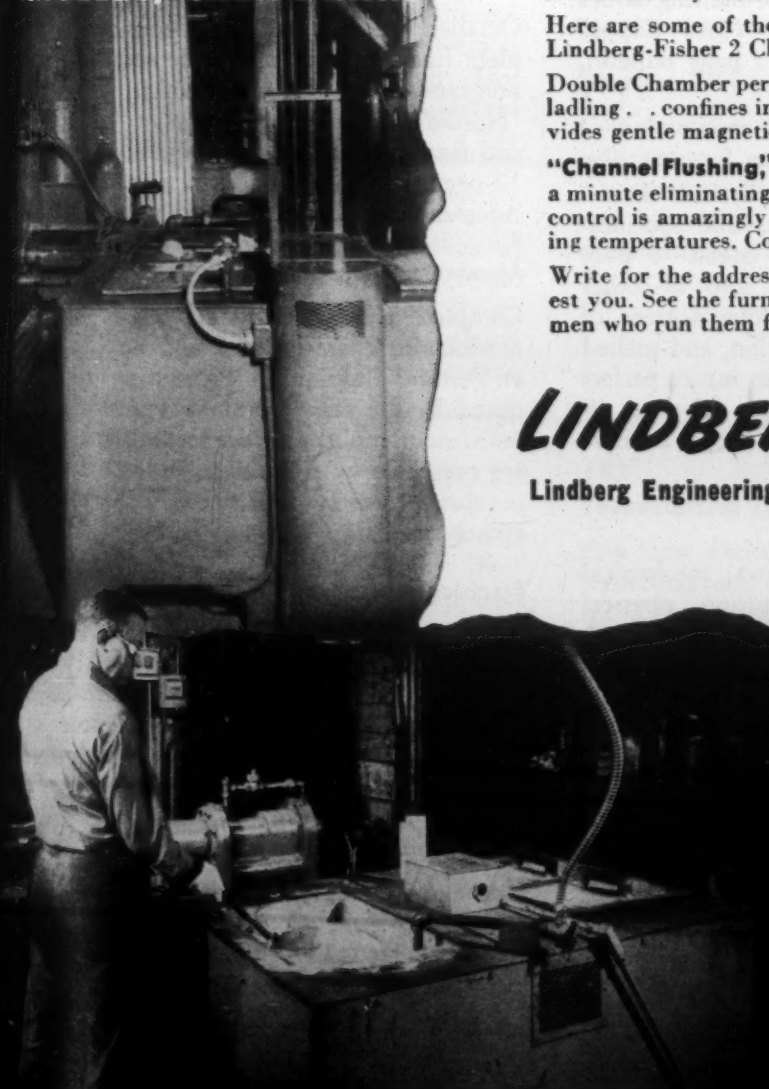
Double Chamber permits simultaneous cold metal charging and ladling . . confines impurities to the charging chamber . . provides gentle magnetic fluxing . . . reduces metal losses.

"Channel Flushing," new patented feature flushes channels twice a minute eliminating channel clogging. Automatic temperature control is amazingly precise—permits the lowest possible casting temperatures. Cool operation improves working conditions.

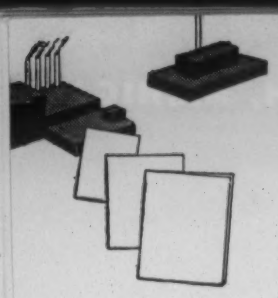
Write for the address of the Lindberg-Fisher installation nearest you. See the furnace in operation, hear for yourself how the men who run them feel about this revolutionary new furnace.

LINDBERG-Fisher MELTING FURNACES

Lindberg Engineering Co., 2451 W. Hubbard St., Chicago, Ill.



NEXT MONTH—Hand ladling will soon be obsolete. Completely automatic nitrogen ladling. Look for our advertisement.



MANUFACTURERS' LITERATURE

Materials

IRON AND STEEL

Cladmetal

The fabrication, physical and mechanical properties, and finishing operations of Rosslyn Metal, a cladmetal with outer surfaces of stainless steel bonded to an interlayer of high conductivity copper, are featured in 28 illustrated data sheets offered by the American Cladmetals Co. (1)

Steel Sheets and Wire

Various grades and tempers of steel sheets, and steel wire for almost every industrial use are described and illustrated, and specifications and handy tables giving the gage for steel sheets, decimal equivalents, and sizes, weights and lengths of round steel wire by steel wire gage included in this 20-page booklet, issued by the Continental Steel Corp. (2)

Steel Analyses Chart

This 8-page folder, No. 301, consists of a detailed analyses chart listing a large assortment of corrosion and heat resisting steels produced by various steel manufacturers. Available from the Globe Steel Tubes Co. (3)

How Steel Is Made

An authentic and comprehensive story of modern steel making, from the mines to finished steel, is informally told in a new 64-page, illustrated booklet, available from the Inland Steel Co. (4)

High-Speed Steels

The analyses, heat treatments and applications of five most commonly used types of high-speed steels produced by the Jessop Steel Co. are featured in this 16-page, illustrated bulletin, No. W-87670. Charts showing the hardnes values after heat treatment are included. (5)

Super Alloys

The latest edition of *Tempil° Topics,* one page, discusses super alloys, which withstand high stresses at temperatures from about 1200 to 2000 F and which are available in both cast and wrought forms. Tempil° Corp. gives tips and techniques in temperature control in each issue of *Tempil° Topics.* (6)

NONFERROUS METALS

Low Temperature Melting Alloys

Physical data in tabular form of the various Cerro-Alloy low temperature melting alloys produced by the Cerro de Pasco Copper Corp. are presented in this 2-page bulletin, No. J2. (7)

Aluminum Bronze

Numerous tables on the physical characteristics, electric conductivity and specification comparisons of Molin Metal—a pure aluminum bronze without iron or other additions, produced in various degrees of hardness to suit the application, and melted and poured the correct way to insure perfect castings—are featured in this 12-page, illustrated bulletin released by the Dirilyte Co. of America, Inc. (8)

Nickel Alloys

Characteristics, applications, mechanical properties, chemical composition, physical constants and available mill forms of a complete line of individualized Inco nickel alloys, including Monel, "R" Monel, "K" Monel, "KR" Monel, "S" Monel, "L" nickel, "Z" nickel and Inconel, are featured in this attractive, 12-page, illustrated bulletin, released by the International Nickel Co., Inc. (9)

Austenitic Alloy

The chemical composition, mechanical properties, physical properties, heat treatment, machinability, etc., of Misco 20-Cast, produced by the Alloy Casting Div. of the Michigan Steel Casting Co., are given in this 2-page bulletin. (10)

Spot Weld and Paint Preparers

This 4-page, illustrated bulletin, No. 46-62, discusses Alumiprep No. 20, a brush-on wipe-off type for preparing aluminum and its alloys for painting, and Alumiprep No. 1, a dip-tank type for preparing aluminum and its alloys for spot welding and painting. Neilson Chemical Co. (11)

PARTS AND FORMS

Tungsten Carbide Blanks and Bushings

Detailed specifications and prices of a complete line of tungsten carbide standard and nonstandard blanks, tool blanks, "Go" and "No-Go" standard plug gage bushings, and ring gage bushings are included in this 12-page, illustrated bulletin, issued by the Adamas Carbide Corp. (12)

Aluminum Alloy Castings

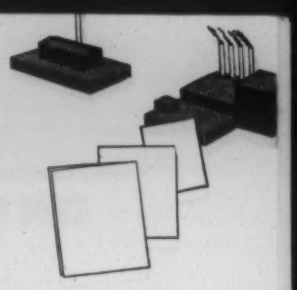
Complete data covering all phases of the production, characteristics and applications of Permite aluminum alloy castings as produced by the sand, permanent mold, semi-permanent mold, and die casting processes are presented by Aluminum Industries, Inc., in this profusely illustrated, 80-page reference manual. (13)

Precision Investment Castings

An interesting article on precision investment castings is presented by the Arwood Precision Casting Corp. in this 16-page, illustrated bulletin, including a table of alloys found by Arwood to be most adaptable to its process. (14)

Steel Tubing

Five data cards available from the Babcock & Wilcox Tube Co. cover the following subjects: No. 115, tolerances of round seamless steel mechanical tubing; No. 112,



MANUFACTURERS' LITERATURE

metric conversion table; No. 110, linear conversion table; No. 103, wall thickness data for seamless and welded tubing; and No. 125, hardness conversion tables. (15)

Drop Forgings

The development of metal quality progressively throughout hot working operations, from the blast furnace to the finished forging, a discussion of forging quality steel and the selection of metals for forgings, steps in making forging dies, etc., are all included in this interesting, 60-page, illustrated catalog published by the Drop Forging Assn. (16)

Wire Rope

Complete data on installing and operating wire rope, selecting the correct wire rope for the job, and the sizes, grades, construction and physical properties of the entire line of standard J & L wire ropes produced by the Jones & Laughlin Steel Corp. are presented in this attractively illustrated, 96-page catalog. (17)

New Screening

Lumite, a new kind of screening woven of Saran, and which is stainproof, rust-proof, lasts a lifetime, and never needs painting, is discussed in this 4-page, illustrated, pocket-size folder, issued by the Lumite Div. of the Chicopee Manufacturing Corp. (18)

Meehanite Metal Applications

The third of a series of new application bulletins, No. 30, describes and illustrates the current uses of Meehanite castings. This bulletin, eight pages, has been published by the Meehanite Metal Corp. (19)

Thermoplastic Extruders, Etc.

Detailed descriptions and specifications of various thermoplastic extruders, an orientation unit, conveyor, granulator and drying cabinet, for use in the extrusion of plastic materials, are presented by the Modern Plastic Machinery Co. in this 4-page, illustrated bulletin, No. MP-10. (20)

Zinc Alloy Die Castings

The more salient features of Zamak-3 and Zamak-5 zinc alloy die castings, their method of production, and typical applications are all reviewed in this 28-page, illustrated booklet, available from the New Jersey Zinc Co. (21)

Chrome Steel Tubing and Bars

A detailed stock list of the complete line of chrome steel tubing and bars supplied in three grades—SAE 52100, PSI #1 or PSI #2—by Peterson Steels, Inc., is available in this 12-page booklet. The chemical analysis of each grade and typical applications are included. (22)

Brass and Bronze Castings

The design, size limitations and tolerances of various brass pressure die castings and aluminum-bronze permanent mold and centrifugal castings are featured in this 10-page bulletin, issued by the Pressco Casting & Manufacturing Corp. (23)

Expanded Metal

Engineering data on all sizes of Ryex standard and Ryex flattened expanded metal, including load deflection, air flow comparison, specifications, typical applications, etc., are presented by the Joseph T. Ryerson & Son, Inc., in its 8-page, illustrated bulletin. (24)

Steel Castings

This useful table of general engineering types of steel castings, classified according to tensile strengths, has been prepared and will be distributed by the Steel Founders' Society of America. (25)

Permanent Magnets

The Thomas & Skinner Steel Products Co. has issued a 20-page, illustrated bulletin containing complete data on the use, design and fabrication of permanent magnets. Composite charts of demagnetization and energy product curves and a table of typical properties are included. (26)

Seamless Tubing

Complete data on Rockrite close tolerance, cold reduced seamless tubing, available in a wide range of metals including many that are difficult, if possible, to cold draw, are presented by the Tube Reducing Corp. in this attractive, 20-page, illustrated bulletin. (27)

PLASTICS

Thermosetting Resins

Five new thermosetting resins for use in protecting and repairing metal equipment for corrosive service are discussed by the Carboline Co. in its 4-page, illustrated bulletin, No. C-2. Typical applications and complete instructions on how to use these resins are included. (28)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 129.

Laminated Plastics

Complete instructions on how to veneer and fabricate Formica laminated plastics, including choice of materials, tools and other equipment, gluing, pressing, edging, etc., are presented by the Formica Co. in this 4-page, illustrated bulletin, No. 110. (29)

Plastics Molding Material

The General Electric Co. has announced in a 6-page folder, No. CDC-12A, the availability of G-E 12446, a Hycar rubber-phenolic compound possessing excellent shock resistance and moldability, as well as easy preforming. A complete list of powder properties and properties of molded test specimens is included. (30)

Plastics

Data on the physical properties of Tenite I, a cellulose acetate plastic, and Tenite II, a cellulose acetate butyrate plastic, in the types, formulas and flows regularly supplied for molding and extrusion, together with other information of use in specifying Tenite for various applications, are presented in this 46-page catalog, fifth edition, published by the Tennessee Eastman Corp. (31)

NONMETALLICS

Electrical Porcelain

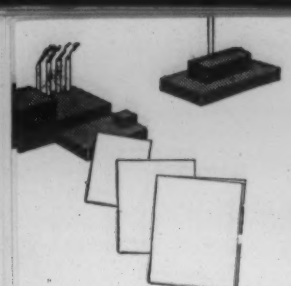
An interesting article on the electrical and physical properties of electrical porcelain, an excellent insulating material, is presented by the National Ceramic Co. in this 24-page, illustrated booklet. (32)

Carbon Brushes for Electrical Machines

All types and sizes of USG carbon and carbon-graphite, electrographitic, graphite, and metal-graphite brushes for electrical machines, available in production lots or for replacement purposes, are described and illustrated in this attractive, 44-page catalog, No. B-49, available from the United States Graphite Co., Div. of the Wickes Corp. A helpful table of characteristics, descriptions and uses is included. (33)

Vulcanized Fibre

This 4-page, illustrated bulletin includes the physical properties and a comparison chart of Wilmington vulcanized fibre and Fyberoid (fish paper), available in sheets and continuous rolls. The Wilmington Fibre Specialty Co. states that its fibre is a



MANUFACTURERS' LITERATURE

perfect all-purpose electrical insulating material. (34)

Methods and Equipment

HEAT TREATING

Electric Heat Treating Furnaces

This 20-page folder contains four illustrated bulletins, a price list, and instructions on how to select the proper small electric heat treating furnace, supplied with automatic temperature control and produced by the Cooley Electric Manufacturing Corp. Specifications and accessory equipment data are included. (35)

Controlled Atmosphere Furnace

The principles of operation, constructional features and specifications of a controlled atmosphere furnace that meets every heat treating problem on all types of steel are included in this 16-page, illustrated bulletin, released by the Delaware Tool Steel Corp. (36)

High Temperature Electric Tube Furnace

Bulletin No. 1148, published by the Harper Electric Furnace Corp., describes and illustrates a high temperature electric tube furnace especially designed for general research work. A useful chart of typical heating and cooling curves is included. (37)

Electric Furnaces

A complete line of "Certain Curtain" controlled-atmosphere electric furnaces and auxiliary equipment is described and illustrated in this 32-page bulletin, No. 110, issued by C. I. Hayes, Inc. Specifications are included. (38)

Electric Radiant Heaters

A group of illustrated bulletins containing complete data on all-metal Chromalox electric radiant heaters is offered by the Edwin L. Wiegand Co. Actual applications of the RAD heaters are interestingly portrayed. (39)

WELDING AND JOINING

Specifications for Arc Welding Electrodes

Tentative Specifications for copper and copper-alloy metal arc welding electrodes, issued jointly by the American Welding Society and the American Society for Testing Materials, are presented in a 10-page booklet available from Ampco Metal, Inc. (40)

Industrial Fasteners

Time and money-saving case histories that show how Bostitch machines for stapling and wire stitching render better and faster work are reviewed by Bostitch in its 16-page, illustrated bulletin, No. PTG 223. (41)

Aluminum Fasteners

An illustrated stock list of 551 kinds of aluminum screws, machine bolts, nuts, washers and nails, which, when used with wood or aluminum construction, will not rust either on inside or outside installations, is available from the Central Steel & Wire Co. (42)

Welding Electrodes

An interesting little booklet covering complete information on how to choose and use the correct welding electrode is available from the Champion Rivet Co. (43)

Fasteners

This illustrated, single sheet lists 13 excellent reasons for using the wide assortment of Everlasting bolts, nuts, screws, washers, rivets and accessories, in brass, bronzes, copper, Monel and stainless steels, produced by the H. M. Harper Co. (44)

Electrodes for Welding Stainless Steel

Bulletin No. 463, eight pages, contains illustrations and data on the application, properties of deposited metal, procedure and typical applications of a variety of Stainweld electrodes for the shielded arc welding of stainless steels and for surfacing with d.c. Lincoln Electric Co. (45)

FORGING AND FORMING

Hydraulic Presses

The selection, application, design, construction, testing and installation of hydraulic presses are all interestingly illustrated and described in a 16-page bulletin, No. 14[illegible] offered by the Lake Erie Engineering Cor[illegible] (46)

Air Ejection Sets

The many advantages of installing various types of air ejection sets, either cam or ram operated, on standard power presses are discussed in this 6-page, illustrated bulletin No. A-8, released by A. Schrader's Son Div. of the Scovill Manufacturing Co., Inc. (47)

MACHINING

Cutter Grinding

Practical data in tabular and chart form for the correct sharpening of milling cutters, including cutting speed and feeds to be used, are presented by Cincinnati Milling & Grinding Machines, Inc., in this 16-page illustrated booklet, No. M-1657. (48)

Surface Broaching Machines

A complete line of new, improved Dual-Ram surface broaching machines, their design, operation, uses, features, specifications and accessories, are all included in this illustrated bulletin, No. RT-48, released by the Colonial Broach Co. (49)

Band Filing

The many advantageous features of the DoAll Bandfiler for the faster precision band filing of every filing job are profusely illustrated and described in this 4-page bulletin, No. 48-400, available from the DoAll Co. Complete specifications are included. (50)

Jig Borer Cutting Tools

Suggested jig borer cutting tools, the feed, speed and estimated time for each boring operation, constants for converting spindle speeds for different materials, accessories, and numerous tables are all included in this 24-page, illustrated catalog, available from the Moore Special Tool Co., Inc. (51)

Chucking Machine

The Model 365 double-end six-spindle tool rotating chucking machine that is capable of high-speed production in both ferrous and nonferrous metals by working from two sides at once is profusely illustrated and described in this 8-page folder, released by the New Britain Gridley Div. of the New Britain Machine Co. Specifications are included. (52)

End Finishing Machines

Both semi-automatic and full-automatic tube and rod end finishing machines for deburring, chamfering, facing, drilling,

JOHNSON

SLEEVE BEARING DATA

Bearing DESIGN

BRONZE

SLEEVE BEARING DATA

Clearances

OIL CLEARANCE in sleeve-type bearings is that difference in size between the diameter of the shaft and the inside diameter of the bearing. This space accommodates the lubricant, permits the formation of a protective oil film preventing metal-to-metal contact when in operation and allows for expansion due to heat. Bearing performance, bearing life and machine operation are all greatly affected by oil clearances determined through correct dimensions of shaft and bearing.

It is quite impossible to set hard and fast rules for all applications. So many factors go into the successful operation of bearings that each should be given individual study and clearance data decided from the findings. However, certain general standards can be used as a guide towards correct oil clearances.

The above chart lists the average oil clearances most widely used for internal combustion engine applications. This applies to units in which a force feed, pressure lubrication system is used. The vertical clearance is generally maintained to low limits whereas higher clearance is maintained at split line, accomplished by eccentric bore or reliefs at parting line. For splash lubricated bearings, where the engine speed is less than 2000 R. P. M., the minimum oil clearance will be somewhat larger, varying from .0002 to .0006 per inch of shaft diameter.

INTERNAL COMBUSTION ENGINE BEARINGS

Dia. of Crankshaft Journal or Crankpin	*Oil Clearance between shaft and bearing on diameter*	*Crankshaft End Clearance*
2" to 2¾"	.0015 ± .001	.004 to .006
2 13/16" to 3½"	.0025	.006 to .008
3 9/16" to 3¾"	.003	.008 to .010
3⅞"	.0035	.008 to .010
4"	.004	.008 to .010

*This data computed on the use of white or babbitt metals.

BEARING CLEARANCES IN INDUSTRIAL APPLICATIONS

CLASS OF BEARING	*Running Clearance, Thousandths of an inch, for shaft dia. under*				
	½"	1"	2"	3½"	5½"
Precision Spindle Practice—Hardened & ground spindle lapped into the bronze bushing. Below 500 ft./Min. & 500#/Sq. In.	.00025 to .0075	.00075 to 0015.	.0015 to .0025	.0025 to .0035	.0035 to .005
Precision spindle practice—Hardened & Ground spindle lapped into bronze bushing. Above 500 ft./Min. & 500#/Sq. in.	.0005 to .001	.001 to .002	.002 to .003	.003 to .0045	.0045 to .0065
Electric Motor & Generator Practice—Ground Journal in broached or reamed bronze bushing or reamed Babbitt bushing	.0005 to .0015	.001 to .002	.0015 to .0035	.002 to .004	.003 to .006
General Machine Practice (Continuous rotating motion)—Turned steel or cold rolled steel Journals in bored & reamed bronze or poured & reamed babbitt bushings	.002 to .004	.0025 to .0045	.003 to .005	.004 to .007	.005 to .008
General Machine Practice (Oscillating Motion)—Journal & Bearing material as above	.0025 to .0045	.0025 to .0045	.003 to .005	.004 to .007	.005 to .008
Rough Machine Practice—Turned steel or cold-rolled steel Journals in Poured babbitt bearings	.003 to .006	.005 to .009	.008 to .012	.011 to .016	.014 to .020

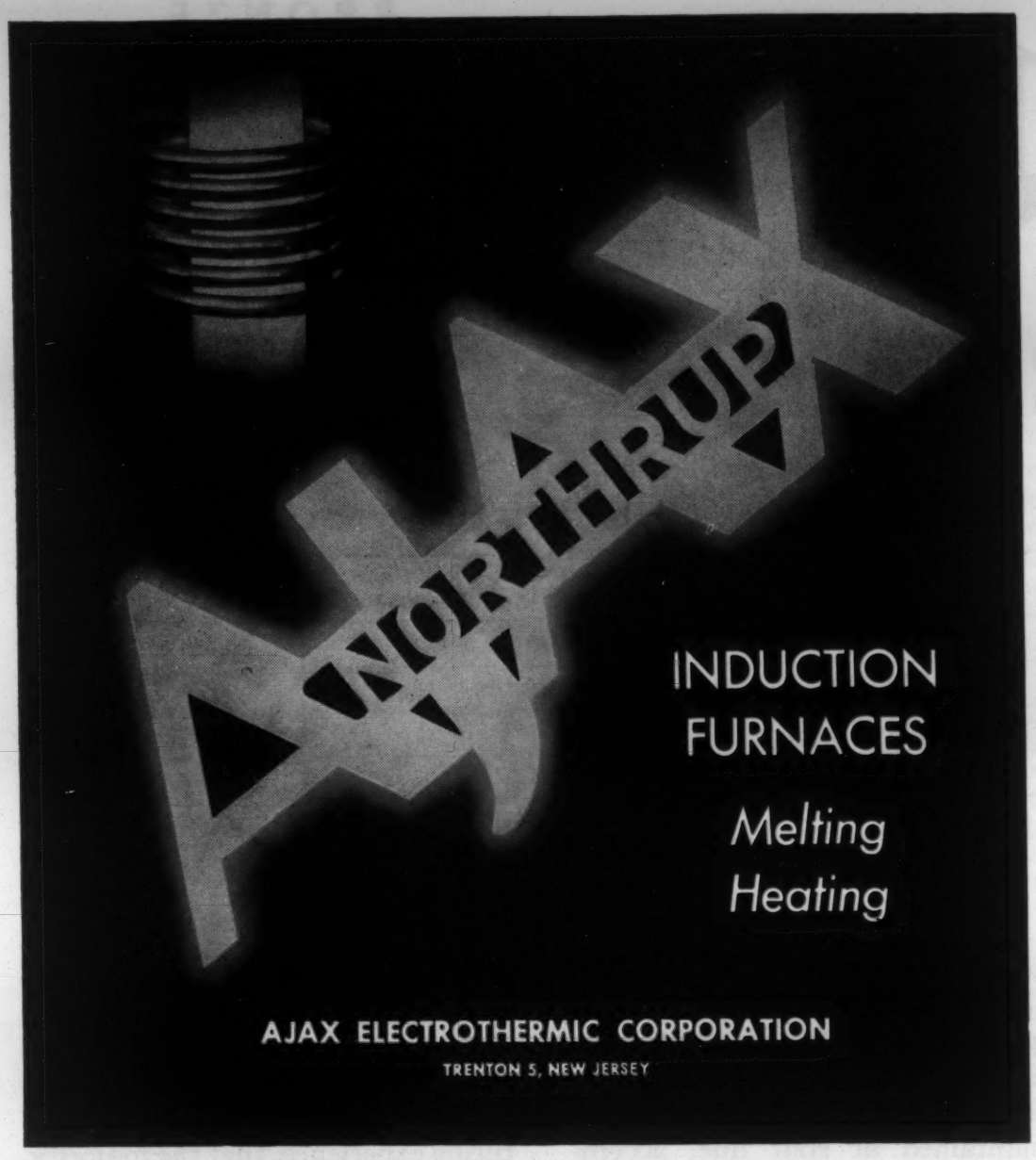
Ordinary industrial applications can be governed by general clearance practice—as listed below. We have found, through more than 40 years exclusive bearing manufacturing experience, that the majority of applications can be so classified. The tolerance range, as shown by the chart, provides ample room for the formation of a protective lubricating film. In certain specific applications, such as some types of machine tools engaged in producing very precise parts, clearances must be held to very close limits.

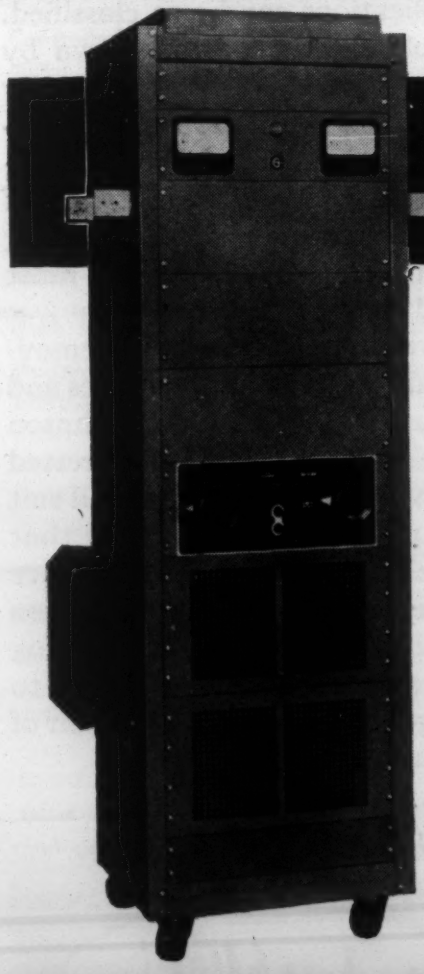
There is one sure way of removing doubt concerning tolerances and oil clearances. Call in a Johnson Bronze Engineer. We are interested in giving you bearings that will suit your applications—bearings that will deliver greater performance and longer bearing life. Our men are trained in all phases of bearing practice. We offer their services to bearing users without obligation of any kind.

This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze

SLEEVE BEARING HEADQUARTERS
769 S. MILL ST. • NEW CASTLE, PENNA.





ELECTROPLATING POWER

The Green Electric line of Rectifiers, for supplying D.C. power, includes over two hundred standard types ranging from 6 volts to 60 volts and from 25 amperes to 5,000 amperes.

In addition Green Electric have engineered several thousand custom-built units for particular applications or unusual plant layouts.

Green Electric, established since 1892, specialize *exclusively* in rectifier equipment.

For details—mail coupon

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GREEN EXCHANGE BUILDING
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RECTIFIER (G) ENGINEERS

W. GREEN ELECTRIC CO., INC.
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Please send me literature on Selectro-Platers and other rectifiers.

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News of...

ENGINEERS COMPANIES SOCIETIES

Engineers

John W. Vanderslice has been named chief industrial engineer of the Oliver Iron & Steel Corp. Mr. Vanderslice formerly was associated with American Associated Consultants, Inc.

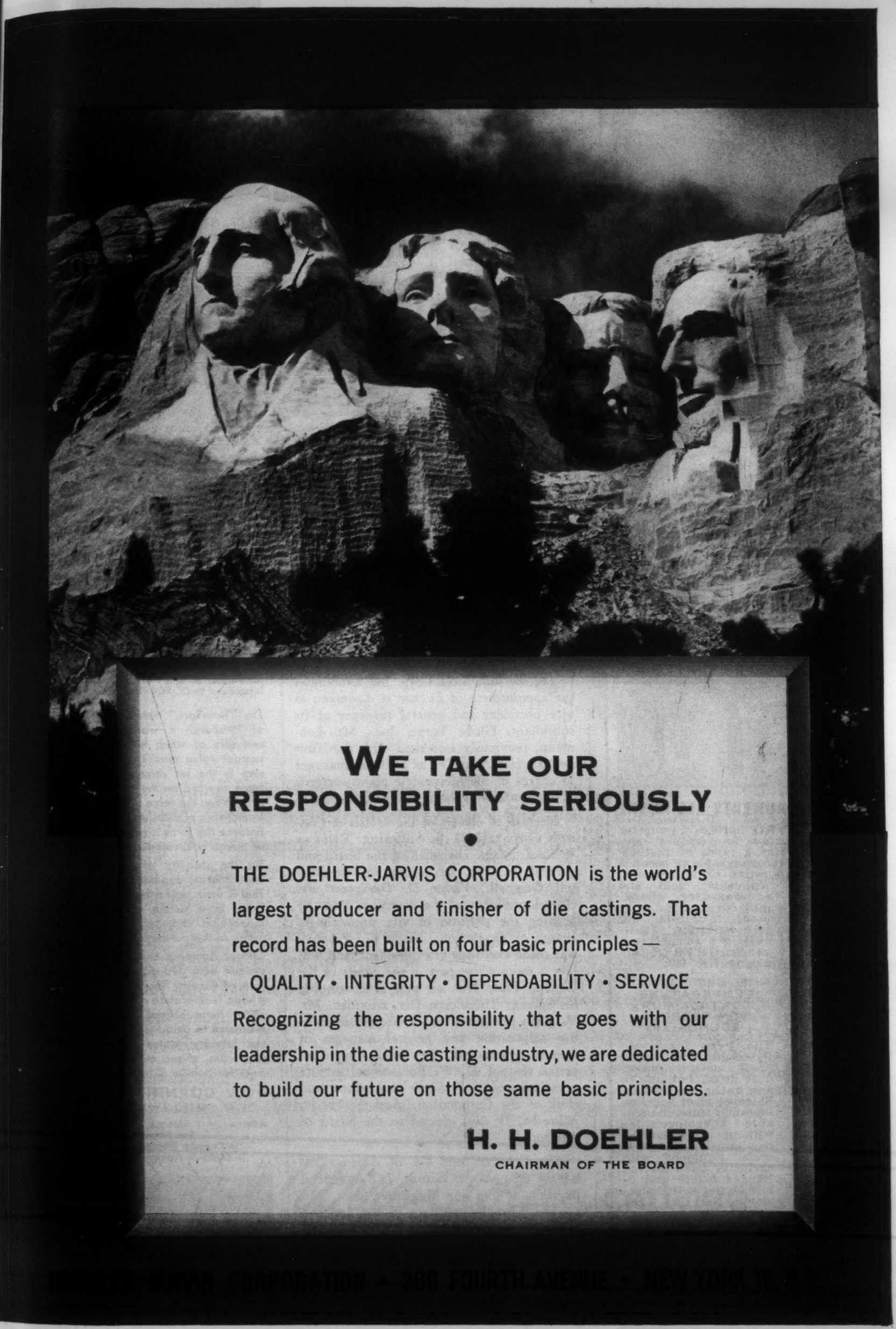
Air Reduction Co., Inc., has announced the appointment of Dr. *G. V. Slottman* as director of engineering and research. He previously was technical assistant to the vice president in charge of sales of Air Reduction.

Two new members were elected to the Board of directors of Arthur D. Little, Inc. They are Professor *Thomas K. Sherwood*, dean of engineering of the Massachusetts Institute of Technology, and Dr. *Bruce S. Old*, in charge of process metallurgy for Arthur D. Little, Inc. *R. C. Griffin* retired as director and assistant secretary under the company's regular retirement plan. The election of officers for 1949 also were held and include *Earl P. Stevenson*, president; *Raymond Stevens, Thorne L. Wheeler* and *Leroy F. Marek*, vice presidents; *Henry G. Powning*, treasurer; *Frank N. Houghton*, secretary and assistant treasurer; *Helge Holst*, assistant secretary; and *Howard J. Billings*, assistant treasurer and assistant secretary.

The National Bureau of Standards recently made three appointments to its staff. They include *William M. Piper*, who will do research in the Ordnance Mechanics Laboratory of the Electronics Div. Mr. Piper formerly was a project engineer in charge of research and development of all batteries and related equipment for the Office of Chief Signal Officer, Dept. of the Army. Dr. *John R. Pellam's* new duties will be concerned with research in the Cyrogenics Laboratory. Previously he was on the staff of the Research Laboratory of Electronics at the Massachusetts Institute of Technology. And Dr. *Ralph L. Nuttall*, who received his Ph.D. from Yale University last June, will do research on the thermal conductivity of gases at elevated temperatures and pressures in the Thermodynamics Laboratory.

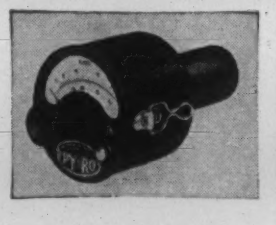
The resignation of Rear Admiral *William Granat*, U.S.N. (Ret.) as treasurer of Lester B. Knight & Associates, Inc., consulting engineers, will take effect this June.

Fred A. Pritzloff has been promoted to


WE TAKE OUR
RESPONSIBILITY SERIOUSLY
•
THE DOEHLER-JARVIS CORPORATION is the world's largest producer and finisher of die castings. That record has been built on four basic principles —
QUALITY • INTEGRITY • DEPENDABILITY • SERVICE
Recognizing the responsibility that goes with our leadership in the die casting industry, we are dedicated to build our future on those same basic principles.
H. H. DOEHLER
CHAIRMAN OF THE BOARD

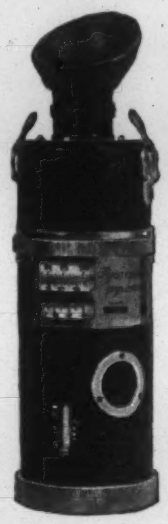
WHY GUESS THE TEMPERATURE . . . When you can SEE it!

PYRO Radiation Pyrometer

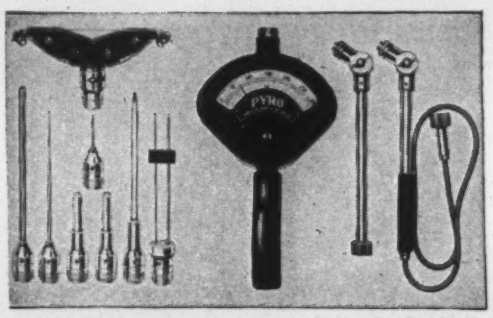


Tells spot temperatures instantly in heat-treating furnaces, kilns forgings and fire boxes. No thermocouples, lead wires or accessories needed! Temperature indicated on direct-reading dial at a press of the button. Any operator can use it. Two double-ranges for all plant needs. **Write for FREE Catalog No. 100.**

PYRO Optical Pyrometer

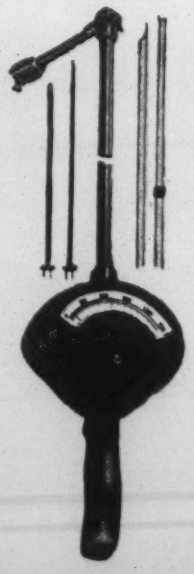


Determines temperatures of minute spots, fast-moving objects and smallest streams — at a glance! No correction charts or accessories needed. Easy to use—weighs only 3 lbs. Special types available to show true spout and pouring temps. of molten ferrous metal measured in open. Five temp. ranges. **Write for FREE Catalog No. 80.**



EIGHT INSTRUMENTS ALL IN ONE

The **NEW PYRO** Surface Pyrometer handles all surface temperature measuring jobs. Has 8 types of thermocouples; all interchangeable in seconds with no recalibration or adjustment. Automatic cold end compensator, shock, moisture and dust proof. Accurate, big 4¾" indicator. Available in 5 temperature ranges. Get FREE Catalogue No. 160.



BETTER TEMPERATURE CONTROL FOR NON-FERROUS FOUNDRIES

The **Pyro** Immersion Pyrometer is shock proof, moisture proof, dust proof, immune to magnetic influences. Shielded steel housing. Instantly interchangeable thermocouples without adjustment or recalibration. Large 4" scale. Equipped with exclusive **Lock Swivel.** Ranges 0-1500 and 0-2500 F. Get FREE Catalogue No. 150.

THE PYROMETER INSTRUMENT CO.
New Plant & Laboratory
BERGENFIELD 27, NEW JERSEY
Manufacturers of Pyro Optical, Radiation Immersion and Surface Pyrometers for over 25 years.

News of...

ENGINEERS COMPANIES SOCIETIES

the position of consultant on foundry problems to Harold F. Falk, vice president and works manager of the Falk Foundry Div. of the Falk Corp. *Carl Haertel* succeeds Mr. Pritzloff as foundry superintendent in full charge of that department.

The promotion of *Leonard R. Shorek* to the position of chief engineer and *James D. Russell* to that of sales manager of the Young Brothers Co. has just been announced.

The National Research Corp. has elected *Robert A. Stauffer* a vice president and director of research.

Raymond B. Seymour has been named executive vice president and general manager of the Atlas Mineral Products Co. Mr. Seymour, formerly chief chemist of Atlas, will direct his attention to the improvement and development of new protective coatings, linings and cements.

The resignation of *Roland C. Disney* as vice president and general manager of the Whitcomb Locomotive Co. became effective last month. *Charles K. Olson* succeeded Mr. Disney as general manager.

The Barium Steel Corp. has announced the appointment of *Eugene A. Lehmann* as vice president and general manager of its subsidiary, Globe Forge, Inc. Mr. Lehmann, previously associated with the Timken Detroit Axle Co. as assistant manager in charge of the Melvindale plant, succeeds *E. Lawton Bishop,* who resigned.

Election of officers of the Metals & Controls Corp. include the following: *Rathbun Willard* became chairman of the board and general manager, succeeding the late Russell Grinnell. *Victor D. Davignon* was elected president of the company, formerly holding the position of vice president in charge of production. *Victor G. Vaughan* was made executive vice president, and will take a more active part in the affairs of the General Plate Div. as well as continuing his Spencer Thermostat Div. activities. Mr. Vaughan previously was a vice president of the corporation and general manager of Spencer Thermostat. Two re-elections comprised that of *H. W. Boessenkool* as vice president and *C. J. Stone* as treasurer and clerk of the Corporation. And *George A. Matteson, Jr.,* was elected to the board of directors.

The Crucible Steel Co. of America has named *Howard M. Givens, Jr.,* as general manager of tool and high-speed sales. Mr. Givens, formerly manager of bar and roll sales for the Midvale Co., will maintain headquarters at Crucible's New York office.

Alwin F. Franz has been appointed an executive vice president of the Colorado Fuel & Iron Corp. and its subsidiary companies. Mr. Franz is also a member of the

Silicone News

DC Dow Corning SILICONES

DC Silicone Fluid Stabilizes Versatile Force Measuring Device

Thrust, torque and other kinds of force are measured by air in a device so sensitive and versatile that the same unit can measure the thrust of a 2000 h.p. engine while responding to the weight of a coin. It is used in the cradle dynamometer measurement of aircraft and automobile engines, the testing of piston rings and axles and automatic batch weighing. And it operates without any movement of the measured system.

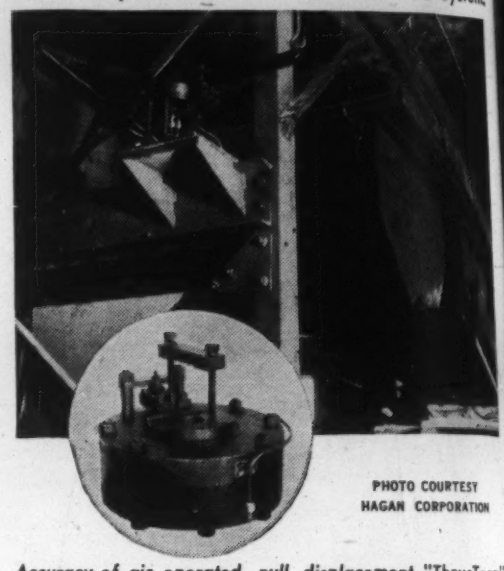


PHOTO COURTESY HAGAN CORPORATION

Accuracy of air operated, null displacement "ThrusTorq" is stabilized by DC 200 Fluid in viscous damper.

The "ThrusTorq" made by Hagan Corporation of Pittsburgh is essentially an air chamber, one side of which is a flexible diaphragm. A poppet valve admits compressed air until pressure in the air chamber exactly balances the force exerted on the diaphragm by the torque arm. When the force is reduced, air is exhausted to maintain equilibrium. Air pressure required to balance the force is registered by a manometer, or gauge calibrated in foot-pounds.

But the stability of a system for balancing inertial forces depends upon adequate damping. That is done most effectively by DC 200 Silicone Fluids in a viscous damper consisting of two diaphragm chambers connected by a small orifice in the partition plate.

Critical damping and more compact hydraulic systems both depend upon the remarkably low rate of viscosity change in DC 200 Fluids over a wide temperature range. For more information about these silicone fluids including data on resistance to oxidation and to mechanical shearing, lubricity, water repellency and dielectric properties, phone our nearest branch office or write for booklet C13 BC2.

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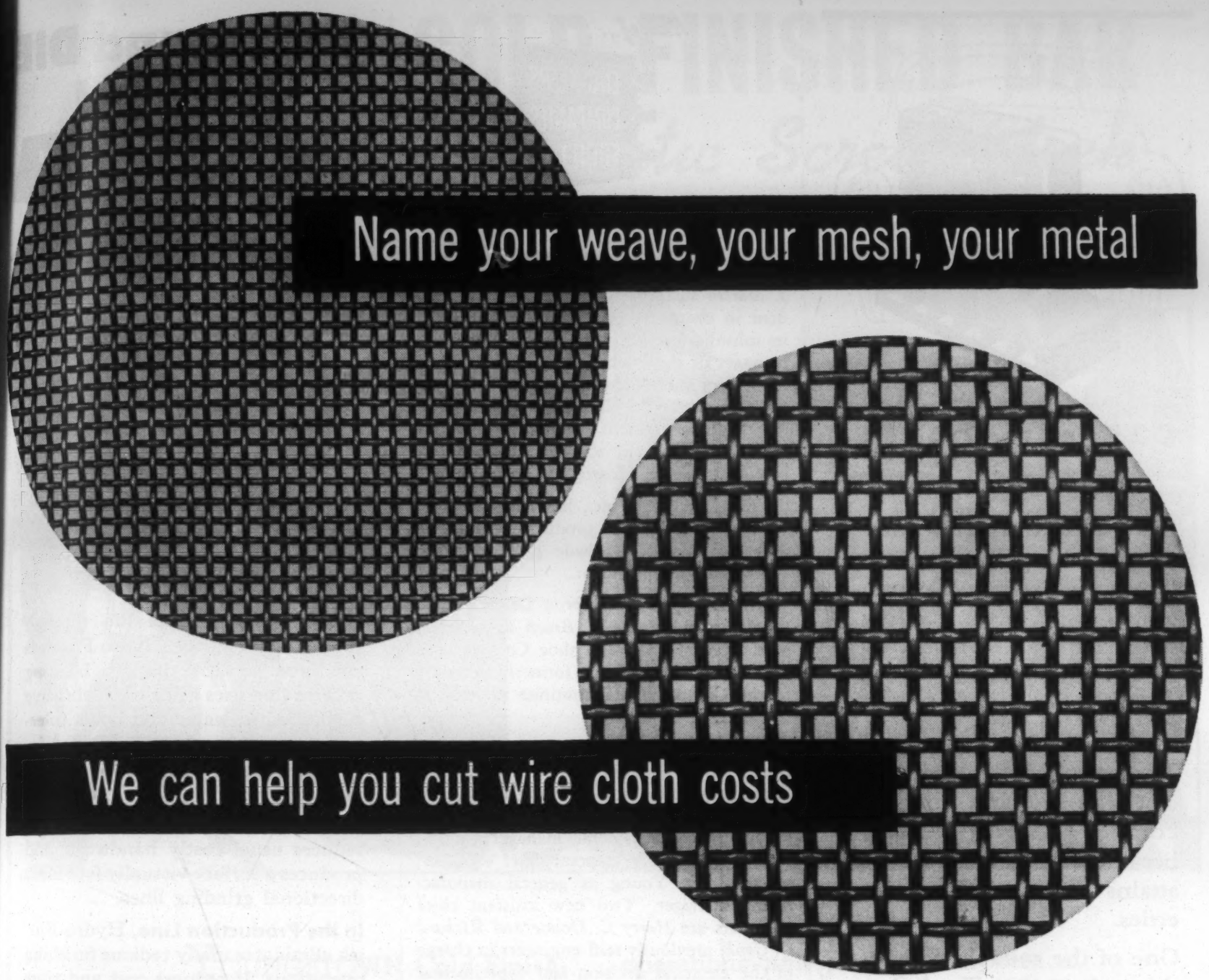

With manufacturing facilities on both the East and West Coasts, and engineering sales service in key cities throughout the nation, we can help you find the answers to your wire cloth problems.

Backed by 90 years' experience, our service to over 100 industries covers the precision fabrication of wire cloth in a dozen different coarse and fine weaves; in all commonly used metals; to withstand chemical action, corrosion, abrasion, moisture, or high temperature.

Whether you use wire cloth for screening, filtering, grading, cleaning, or processing, you'll find Wissco and Calwico Wire Cloth will give long, dependable service.

Super-Tempered PRECISION SCREENS

Even under excessive vibration these screens won't wear loose in service. They're made of tough, super-tempered steel and woven on new modern power looms. Wissco and Calwico Super-Tempered Precision Screens stay tight and accurate throughout a long life. Any length required for vibrating screen or trommel can be furnished with welded, hooked, or reinforced edge to fit any type of vibrator. Write for details.

WISSCO *Wire Cloth* **CALWICO**

East of the Rockies it's **WISSCO**
WICKWIRE SPENCER STEEL
STERLING ST., CLINTON, MASS.

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THE CALIFORNIA WIRE CLOTH CORP.
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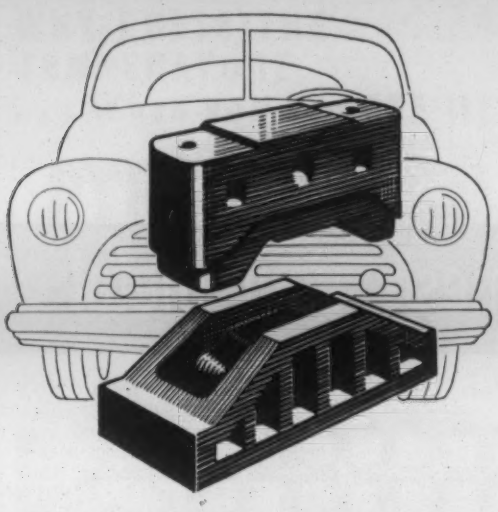

cast-to-form dies

Easy machinability compared with steel, capacity to take a high polish in work, toughness to resist pressing stresses, and above all ability to resist abrasion—these qualities denote a good forming die.

The use of Molybdenum in cast iron dies has now become standard practice, because it most economically attains these desirable properties.

One of the suitable compositions is: 3.40% Total Carbon, 1.40% Silicon, 0.80% Manganese, with 0.25% Chromium, 0.10% Vanadium and 0.50% Molybdenum added.

This composition is one of many listings under "Dies" in our "Applications of Molybdenum Cast Irons"—an alphabetically arranged ready-reference booklet for busy foundrymen and for engineers—write for it!

Climax Molybdenum Company
500 Fifth Avenue
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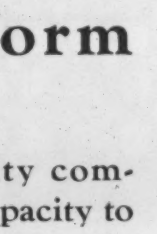

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News of...

ENGINEERS COMPANIES SOCIETIES

board of directors of the Corporation. *Jay J. Martin* succeeds Mr. Franz as vice president in charge of operations of CF&J and its subsidiaries. Mr. Martin, formerly works manager of the Pueblo plant, will maintain his headquarters there; Mr. Franz will have offices both at Pueblo and Buffalo, N. Y. Another appointment was that of *John S. Hawley* as assistant to the executive vice president, his headquarters to be in Buffalo.

Olin Industries, Inc., has named *W. C. Schade* as manager of product divisions for the company. Mr. Schade previously was assistant to the president.

The election of *Kempton Dunn* as vice president and *Cyrus E. Brush* as secretary of the American Brake Shoe Co. has been announced. Mr. Dunn, formerly secretary of the Company, will continue to serve as treasurer.

Several appointments on the staff of the Buick Motor Div. of General Motors have been announced. *O. W. Young* was named to the newly created capacity of executive assistant to the general manager. *E. T. Ragsdale,* formerly assistant chief engineer, succeeds Mr. Young as general manufacturing manager. Two new assistant chief engineers are *Harry C. Doane* and *Richard C. Cook,* previously staff engineers in charge of the electrical division and experimental engineering, respectively.

Paul F. Preston has joined the General Electric Co. as Chemicals Div. manufacturing manager of the Chemical Dept. Mr. Preston, whose headquarters will be at Pittsfield, Mass., formerly was associated with the Allied Chemical & Dye Corp. as assistant to the technical director of its Barrett Div.

The Hydraulic Press Manufacturing Co. has announced the appointment of *J. P. Vederko* as works manager. Mr. Vederko, previously general superintendent of the Cross Co., succeeds *E. J. McSweeny,* who resigned.

The appointment of *R. G. Nielson* as general manager of production and manufacturing for the Mackintosh-Hemphill Co. has just been announced. Formerly, Mr. Neilson was in charge of the roll shop in the Garrison Plant of Mackintosh-Hemphill.

Companies

The *Crucible Steel Co. of America* has completed the plant improvement and expansion of its *Spaulding Works* at Harrison, N. J. The expanded manufacturing, research and development, and distribution

TOOL and DIE USERS!

Pangborn "Hydro-Finish" Can Help You...

It improves surface finish, removes oxide scale, increases tool and die life through proper maintenance. Hydro-Finish is the new versatile impact blasting process that uses a fine mesh abrasive suspended in water and holds tolerances to .0001 inches.

In the Tool Room, Hydro-Finish simplifies the manufacture and maintenance of tools, dies and molds. It reduces usual costly handwork and produces a surface virtually free from directional grinding lines.

In the Production Line, Hydro-Finish eliminates many tedious finishing operations. It reduces cost and time involved in buffing. It improves fatigue life of the metal parts it finishes. It cuts many manufacturing costs.

It can be used for deburring, surface finishing and lubrication control, removing heat treat scale and discoloration, preparing surfaces for plating or coating, removing directional grinding lines, finishing threaded section for better workability and fit, improving manufacturing, maintenance and life of tools and dies, general maintenance cleaning.

Find out today how Hydro-Finish can pay off for you. Write for Bulletin 1400 to PANGBORN CORPORATION, 1203 Pangborn Blvd., Hagerstown, Md.

Look to Pangborn for all the latest developments in Blast Cleaning and Dust Control Equipment.

Pangborn

BLAST CLEANS CHEAPER with the right equipment for every job

COLD FINISHED BAR

Automatic Screw Stock

YOUNGSTOWN Cold Finished Carbon and Alloy Steel Bars are now being produced in a wide range of sizes and shapes, supplied either in coils or straight lengths.

Drawn to meet standard specifications, these bars have the characteristics that make them ideal for high-speed screw machine operations--uniformity of composition, toughness and strength, close tolerances in dimension, and smoothness and brightness of finish.

You'll find a Youngstown bar stock to meet almost any requirements. Tell our representative what you want and we will make every effort to serve you at once.

QUALITY V YOUNGSTOWN SERVICE

Youngstown

COLD FINISHED CARBON AND ALLOY STEEL BARS

THE YOUNGSTOWN SHEET AND TUBE COMPANY

General Offices — Youngstown 1, Ohio

Manufacturers of Carbon, Alloy and Yoloy Steel

Export Office - 500 Fifth Avenue, New York

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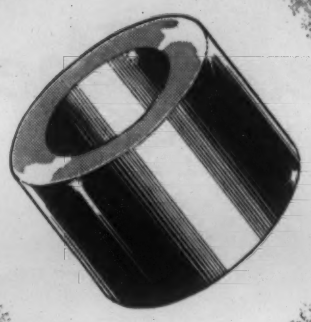
WORKS WHERE OTHERS WON'T



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GRAPHALLOY OILLESS BEARINGS

SPECIFY GRAPHALLOY TRADE MARK REG. U. S. PAT. OFF. WITH CONFIDENCE

SELF-LUBRICATING ● EXTREMELY DURABLE ● CONSTANT CO-EFFICIENT OF FRICTION ● OPERATES DRY — OR *SUBMERGED IN WATER, GASOLINE OR CORROSIVE LIQUIDS* ● APPLICABLE OVER A WIDE TEMPERATURE RANGE — *even where oil solidifies or carbonizes* ● EXCELLENT AS A CURRENT-CARRYING BEARING.

GRAPHITE METALLIZING CORPORATION

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News of...

ENGINEERS COMPANIES SOCIETIES

facilities of the Spaulding Works will greatly aid in the production of a wide range of cold rolled alloy, stainless and high carbon steel specialties, as well as magnets, precision castings, cast alloy tools and alloy welding rods.

A custom-Vinyl plastic compounding service has been set up by the *Transcription Div.* of the *Muzak Corp.* at the *Elizabethtown Corp.*, a Muzak subsidiary in Elizabethtown, Ky. The Vinylite compounds will be marketed to molders of plastic products in three forms—sheet plastic, plastic pre-forms, and granular plastic.

The purchase of the *Bellis Heat Treating Co.*, Branford, Conn., by the *Crown Chemical Corp.*, Guilford, Conn., has been announced. Bellis will continue to operate as a separate entity, but will benefit from the research facilities of Crown Chemical.

Premium Plastics, Inc., has recently opened a plastics plant in Verona, Ohio. Specializing in the manufacture of tailor-made plastic premiums for sales promotion purposes, the plant contains a creative staff purposely to provide complete plastic service from idea creation to shipment of the finished product. George F. Waite, formerly associated with the Celanese Plastics Corp., is president and sales manager. Melvin Kemper, previously with the Inland Div. of General Motors, was named plant manager. Other officials of the firm are Bradley Schaeffer, vice president, and Stewart L. Sheldon, secretary and treasurer.

The *Harcast Co.* has moved to its new plant, located at Glenolden Ave. and Hook Rd., Glenolden, Pa.

A special custom molding service for thermosetting parts up to 16 oz. in weight, performed on the Rockford Hy-Jector 8-oz. and 16-oz. machines, has been announced by the *Rockford Machine Tool Co.*, Rockford, Ill.

The appointment of the *Central Steel & Wire Co.*, Chicago 80, as distributors of aluminum fasteners in the Midwest has been announced by the *Aluminum Co. of America*, Pittsburgh 19, Pa.

The *United States Plywood Corp.* has just opened a new warehouse in Glendale, Calif., which will carry a complete line of Weldwood plywood and affiliated products. Fred B. Smales will manage the new addition.

The exclusive sales agency for handling cladmetals manufactured by the *American Cladmetals Co.*, Carnegie, Pa., has been assigned to *Williams & Co., Inc.*, Pittsburgh, Pa. The territory includes Western Pennsylvania, Ohio, Kentucky and West Virginia.

The headquarters plant and warehouse of the *National Plastic Co.* has been moved

"Oakite's new method for cleaning brass and copper before nickel and chrome plating is tops!"

From Connecticut to California, electroplaters are enthusiastic about the NEW Oakite brass-cleaning method that gives good protection against tarnish along with effective removal of oils and buffing compounds. Here are a few comments:

Wonderful cleaner for brass . . . Results have been excellent . . . Not a single reject on brass and copper work in two months . . . Good cleaning combination . . . All parts plate perfectly . . . Worth its weight in gold . . . No discernible tarnish during anodic cleaning . . . Rejects at lowest point ever . . . Nickel plate extremely adherent, very bright and lustrous . . . Getting excellent results in automatic plating machine . . . 15 to 20 seconds reverse did perfect job . . . Much brighter plating, much better adhesion . . . Could not detect any tarnish . . .

FREE Write today to Oakite Products, Inc. 34E Thames St., New York 6, N. Y., for full information.

OAKITE

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SPECIALIZED INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

Technical Service Representatives Located in Principal Cities of United States and Canada

Jobs that demand precision—

—they're the jobs for DEWARD Oil-Hardening Tool Steel

For Complete Data, write for the DEWARD BLUE SHEET

Contains full information, certified as laboratory tested and proved, on the physical properties and characteristics of DEWARD Tool Steel, and best methods of handling and treatment. *Send for your copy.*

ADDRESS DEPT. MM-74

Wherever your specifications call for hardened machine parts in precision work, you'll gain greatest advantage by using DEWARD Oil-Hardening Tool Steel—famous for its freedom from distortion after heat treatment.

This quality caused the selection of DEWARD for the complete set of precision gears illustrated above, which must run absolutely true in operation. After grinding, the gears are heat treated at 1425-1500° F., oil-quenched and then drawn at 750° F., resulting in a hardness of 48-51 Rockwell C. With no distortion, the final regrind and lapping of the bolt before assembly becomes a simple, quick, low-cost operation.

For any jobs of this general nature, let us show you how DEWARD can save you time and money in production, give you a better finished job—*or both!* Our Mill Service Staff is at your command, without obligation.

ALLEGHENY LUDLUM STEEL CORPORATION
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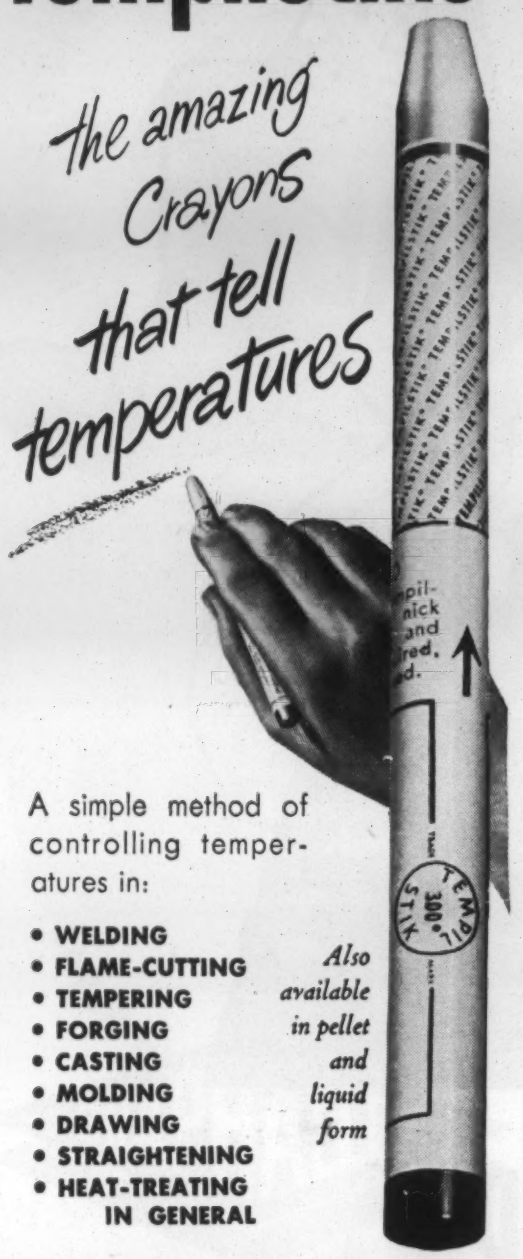
TOOL STEEL DIVISION: DUNKIRK, N. Y.

Fine Tool Steels Since 1854 W&D 1779

Tempilstiks°

the amazing Crayons that tell temperatures



A simple method of controlling temperatures in:

- **WELDING**
- **FLAME-CUTTING**
- **TEMPERING**
- **FORGING**
- **CASTING**
- **MOLDING**
- **DRAWING**
- **STRAIGHTENING**
- **HEAT-TREATING IN GENERAL**

Also available in pellet and liquid form

It's this simple: Select the Tempilstik° for the working temperature you want. Mark your workpiece with it. When the Tempilstik° mark melts, the specified temperature has been reached.

$2 each

gives up to 2000 readings

Available in these temperatures (° F)			
125	275	500	1100
138	288	550	1150
150	300	600	1200
163	313	650	1250
175	325	700	1300
188	338	750	1350
200	350	800	1400
213	363	850	1450
225	375	900	1500
238	388	950	1550
250	400	1000	1600
263	450	1050	

FREE —*Tempil° "Basic Guide to Ferrous Metallurgy"* — 16¼" by 21" plastic-laminated wall chart in color. Send for sample pellets, stating temperature of interest to you.

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Specialists for 33 Years in the Heat Treating and Temperature Control Field

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News of...

ENGINEERS COMPANIES SOCIETIES

from its Los Angeles, Calif., location to new and larger quarters at 2591 E. Foothill Blvd., Pasadena 8, Calif.

The *Wright Manufacturing Co.* expects to complete its new plastics molding service plant in Houston, Tex., sometime this month. The company will produce custom molded plastics for industrial and consumer markets, as well as many molded rubber items.

An educational training film, entitled "Molding on a Jolt Roll-Over Pattern Draw Machine," is being offered by the *Cooper Alloy Foundry Co.* to any engineering school, society or club interested in foundry practices. The 22-min., 16-mm. film will be furnished free on request. Applications should be addressed to Miss R. B. Kubert, Librarian, Cooper Alloy Foundry Co., Hillside, N. J.

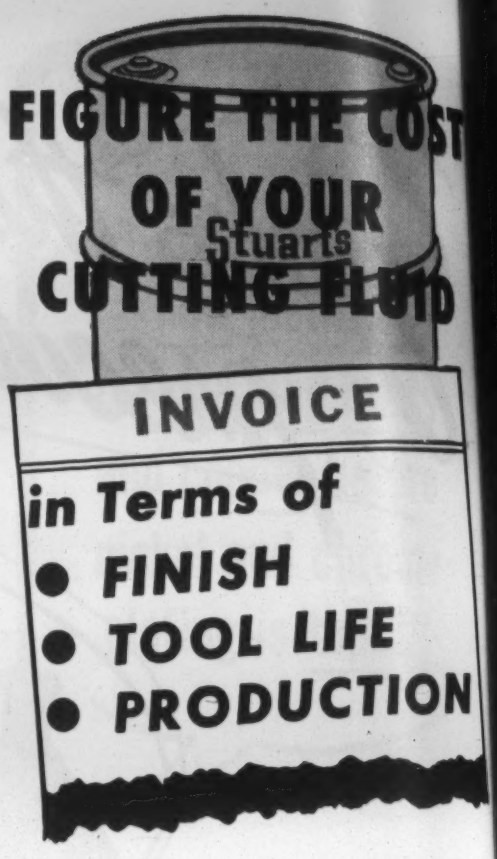
Societies

Frank T. Sisco, director of Alloys of Iron Research, has been appointed technical director of the *Engineering Foundation,* a joint research agency of the *American Society of Civil Engineers,* the *American Institute of Mining & Metallurgical Engineers,* the *American Society of Mechanical Engineers,* and the *American Institute of Electrical Engineers.* Mr. Sisco will continue with Alloys of Iron Research for the present.

Alexander L. Feild received an honorary degree of Doctor of Science from the *Stevens Institute of Technology* for his achievements in the field of science. Mr. Feild is associate director of the Research Laboratories, Rustless Div., Armco Steel Corp.

The *American Society of Body Engineers* elected the following officers for the ensuing year: president—Arthur L. Bradley, chief engineer of the Wettlaufer Manufacturing Co.; vice president—Carl W. Cenzer, body development engineer of Hudson Motor; secretary—Harold V. Atnip, assistant chief body draftsman of Chrysler Corp.; and treasurer—William K. Norwick, executive assistant of the general director, Engineering Div., Fisher Body.

Orrin B. Wernst has been appointed managing director and counsel of the *Pressed Metal Institute,* and Jerry Singleton was named assistant manager. Mr. Werntz will continue his duties as executive secretary of the National Screw Machine Products Assn. in addition to his new assignment. The offices of PMI are now located at 13210 Shaker Square, Cleveland 20.



IT is *wise economy* to buy cutting fluids on a basis of performance rather than on a price basis. This is borne out by the case of a large screw products company in Chicago machining 11/16" round stainless steel types 303 and 440. Operations include forming, drilling and reaming on a New Britain-Gridley automatic screw machine. A number of different cutting oils had been used on this job until one was found that seemed to give relatively satisfactory performance. However, this product was replaced after the first trial with Stuart's Thred-Kut. Not only was there a marked improvement in finish, but *tool life was increased 3 to 4 hours and daily production was increased.*

The above case study is a typical example of how the best cutting fluid for the job will pay its original cost over and over again. D. A. Stuart Oil Company representatives preach the gospel of "Wise Economy." They can help you cut costs with cutting fluids best suited to your requirements. Ask for booklet, *Cutting Fluids for Better Machining.*

STUART *service goes with every barrel*

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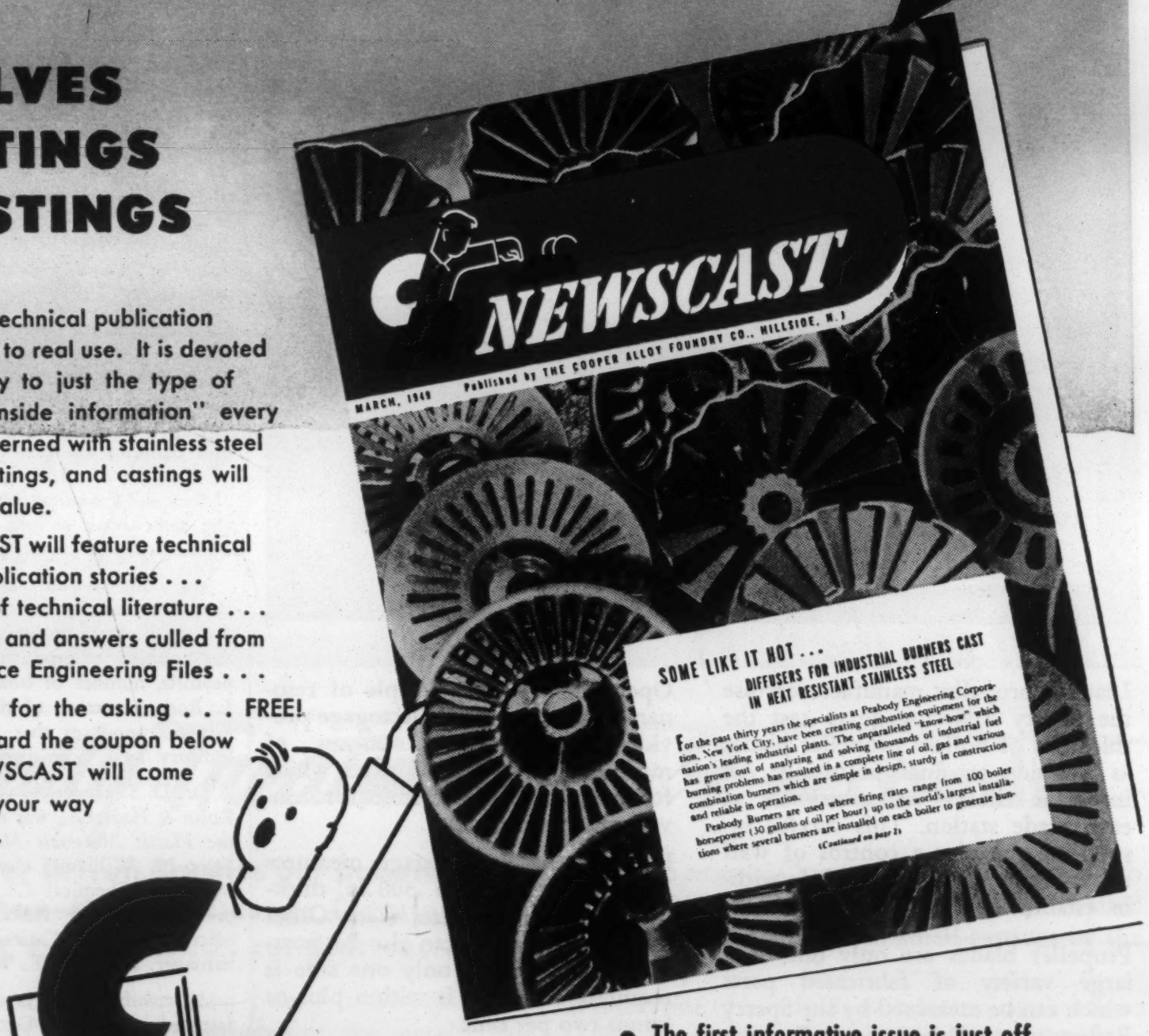
NEWSCAST
MARCH, 1949 Published by THE COOPER ALLOY FOUNDRY CO., HILLSIDE, N. J.
SOME LIKE IT HOT . . .
DIFFUSERS FOR INDUSTRIAL BURNERS CAST IN HEAT RESISTANT STAINLESS STEEL
For the past thirty years the specialists at Peabody Engineering Corporation, New York City, have been creating combustion equipment for the nation's leading industrial plants. The unparalleled "know-how" which has grown out of analyzing and solving thousands of industrial fuel burning problems has resulted in a complete line of oil, gas and various combination burners which are simple in design, sturdy in construction and reliable in operation.
Peabody Burners are used where firing rates range from 100 boiler horsepower (30 gallons of oil per hour) up to the world's largest installations where several burners are installed on each boiler to generate hun-
(Continued on page 2)

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THE WORLD'S LARGEST FOUNDRY DEVOTED EXCLUSIVELY TO THE CASTING OF STAINLESS STEEL

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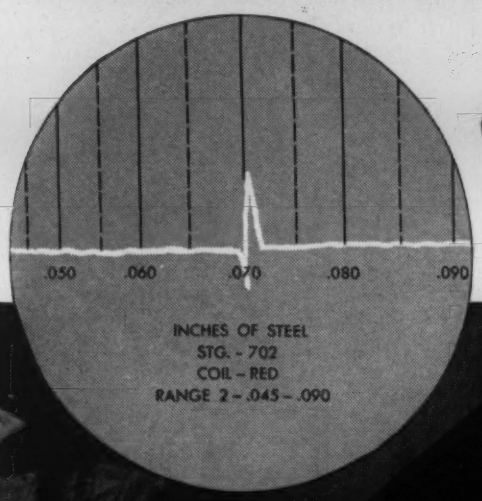
SPERRY REFLECTOGAGE

TESTS THICKNESS OF PROPELLER BLADES BEFORE FINAL POLISHING



Inspection of Propeller Thickness With REFLECTOGAGE CURTISS-WRIGHT CORP. Propeller Division Caldwell, N. J.

Leading propeller manufacturers use the Sperry Reflectogage to test the thickness of hollow propeller blades as a guide to final polishing. An inspector checks wall thickness at each blade station. This careful inspection provides a control of wall thickness throughout the blade within established wall thickness limits.

Propeller blades are only one of a large variety of fabricated parts which can be measured by the Sperry Reflectogage. Others include long tubes, formed hollow parts, blades and sheet stock, large tanks and boilers.

Operating on the principle of resonant frequency, the Reflectogage provides an economical means of measuring thickness of parts which formerly were inaccessible for convenient measurement.

In steel, the Reflectogage measures *directly* from .025 to .300 in. thickness, *indirectly* up to 4 in. Other metals and plastics can also be measured. Access from only one side is required. Accuracy is within plus or minus two per cent.

For full information on the Sperry Reflectoscope, write for your free copy of Bulletin 3700. F-4

SPERRY REFLECTOSCOPE

Instantly, accurately locates smaller defects . . . penetrates deeper into metals than any other non-destructive testing device. Saves valuable time lost in machining defective material, minimizes rejects. Read all the facts on the Sperry Reflectoscope in Bulletin 3001. F-4 SP-143

SPERRY

SPERRY PRODUCTS, INC.
DANBURY, CONNECTICUT

News of...

ENGINEERS COMPANIES SOCIETIES

Six prize awards totaling $2,250 for t best papers on designing for, applicati of, and research in resistance welding, su mitted to the *American Welding Soci* prior to Aug. 1, 1949, have been a nounced by the *Resistance Welder Ma facturers' Assn.* Both industrial and u versity sources are eligible. Copies of t rules governing the awards are availab from the Resistance Welder Manufacture Assn., 505 Arch St., Philadelphia 6, P

The *Stevens Institute of Technolog* elected Willis H. Taylor, Jr., as chairma of the Trustees of the College, followin the resignation of Robert C. Stanley aft serving 12 years in this capacity. M Taylor is a member of the New York la firm of Pennie, Edmonds, Morton Barrows.

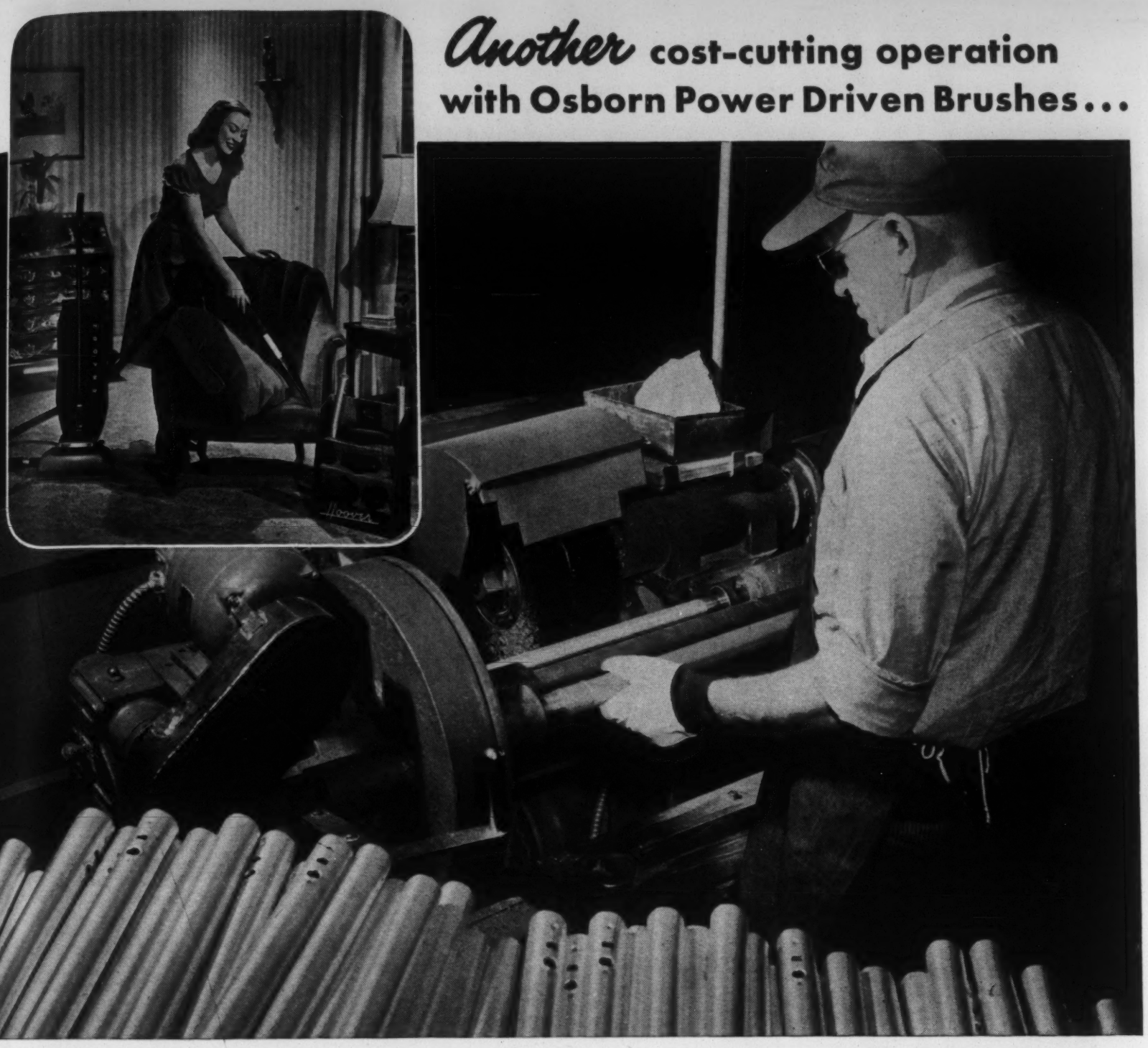
"Development of the Metal Casting Industry" was selected as one of the "5 Books of the Year" in a competition re cently sponsored by the *Institute of Graphi Arts.* Another award for superior desig and printing was presented by the *Socie of Typographic Arts* to the publishers, th *American Foundrymen's Society,* naming the same book as one of the three bes books produced in the past year.

An industry-wide statistical service has been launched by the *Gray Iron Founder Society* to obtain monthly figures on production, number of production employees, total payrolls, number of hours worked, etc. E. L. Roth, chairman of the Statistical Committee, announces that 2500 units in the industry have been invited to participate.

Dr. D. S. Frederick, vice president of the Rohn & Haas Co., was elected president of the *Plastic Materials Manufacturers' Assn.* Felix N. Williams, vice president of the Monsanto Chemical Co., was elected vice president of the Association. Re-elected officers were F. H. Carmen, secretary-general manager, and John E. Walker, treasurer.

An exhibition of products being manufactured in Western Germany will be held at the *Museum of Science and Industry,* Rockefeller Plaza, New York, Apr. 9 to 24. The exposition is being sponsored by the Military government. Its purpose is to show the latest German industrial developments in Germany and to stimulate trade between Germany and United States.

New officers of the *Wire Rope Institute,* elected at their recent annual meeting, include David Larkin as president. Mr. Larkin, executive vice president of Broderick & Bascom Rope Co., succeeds E. C. Low, who became chairman of the board. H. C. Parker, Bergen Wire Rope Co., was elected vice president; secretary is W. A. Huber, American Chain & Cable Co.; and treasurer, D. W. Vernon, A. Leschen & Sons Rope Co.



Another cost-cutting operation with Osborn Power Driven Brushes...

Beauty Treatment in 9 seconds

Osborn Power Driven Brushes put smooth, satin finish on Hoover Electric Cleaner parts in just 9 seconds . . . cut unit cost.

YOU'RE looking at a fast-working 'beauty treatment' performed by Osborn Power Brushes on the metal "skin" of a Hoover Electric Cleaner Extension Tube.

Hoover, a leading manufacturer of fine vacuum cleaners and exponent of the triple-action cleaning principle—it beats...as it sweeps...as it cleans—uses Osborn Power Driven Brushes to produce the smooth, satin finish on extension tubes supplied with its kit of cleaning tools

Powered by a semi-automatic machine, eight Osborn 12" Monitor® Wire Brushes revolve at 1725 R.P.M., applying a rich, beautiful lustre to the extruded metal tubing *in just 9 seconds!* One set of brushes satin finish more than 200,000 tubes . . . after which they are used in another department to brush small castings by the off-hand method.

This is just one of hundreds of industrial applications in which longer-lasting Osborn Brushes are lowering production costs. Perhaps Osborn Power Driven Brushes can help *you* to greater savings through more efficient operation. Write—

THE OSBORN MANUFACTURING COMPANY
Dept. 131, 5401 Hamilton Avenue *Cleveland 14, Ohio*

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WORLD'S LARGEST MANUFACTURER OF BRUSHES FOR INDUSTRY • POWER DRIVEN BRUSHES • PAINT BRUSHES • MAINTENANCE BRUSHES

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ABOUT: *Cutting Costs! Improving Products!*

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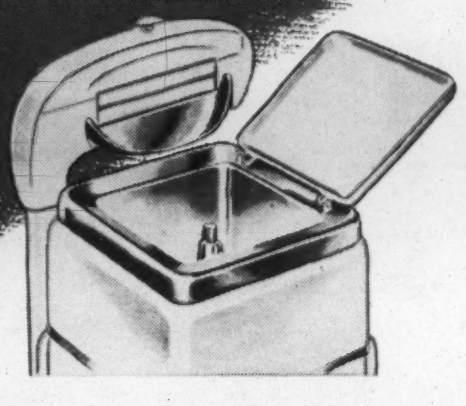
STAINLESS CLAD STEEL

The Clad Steel That's Truly Corrosion Resistant! Easily Formed or Deep Drawn!



The Finer the Finish, The Finer the Product For the Finest Finish Use PERMACLAD

Does the material you are now using cost too much for you to fabricate your product from it profitably? Then learn the advantages of using Permaclad, the ultra modern Stainless Clad Steel. Permaclad combines the surface characteristics of Stainless Steel with the forming qualities of Carbon Steel. It has excellent cold forming properties. Shower stalls, bar-room rails and many other products are now being made of Permaclad.

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STAINLESS CLAD STEEL

It will pay you to get complete information about this corrosion resistant, cost-saving steel now. Free literature on request. Alan Wood Steel Company, Conshohocken, Pennsylvania. Dept. P-35

ALAN WOOD STEEL CO. ESTABLISHED -AW- 1826 CONSHOHOCKEN, PA.

A Product of ALAN WOOD STEEL COMPANY

Other Products: *AW Super Grip Abrasive Floor Plate AW Super-Diamond Floor Plate • Billets • Plates • Sheets (Alloy and special grades).*

Meetings and Expositions

AMERICAN ZINC INSTITUTE, annual meeting. St. Louis, Mo. Apr. 11-12, 1949.

SOCIETY OF AUTOMOTIVE ENGINEERS, aeronautic and air transport meeting. New York, N. Y. Apr. 11-13, 1949.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS, annual conference and exhibition. Cincinnati, Ohio. Apr. 11-14, 1949.

AMERICAN SOCIETY FOR METALS, Western metal congress and exposition. Los Angeles, Calif. Apr. 11-15, 1949.

MIDWEST POWER CONFERENCE. Chicago, Ill. Apr. 18-20, 1949.

MAGNESIUM ASSOCIATION, annual meeting. Chicago, Ill. Apr. 19-20, 1949.

SOUTHERN GAS ASSOCIATION, annual convention. Biloxi, Miss. Apr. 20-22, 1949.

AMERICAN SOCIETY OF CIVIL ENGINEERS, spring meeting. Oklahoma City, Okla. Apr. 20-23, 1949.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Institute of Metals Div., New England regional meeting. Springfield, Mass. Apr. 22-23, 1949.

AMERICAN CERAMIC SOCIETY, national meeting. Cincinnati, Ohio. Apr. 24-28, 1949.

INTERNATIONAL ACETYLENE ASSOCIATION, annual convention. Pittsburgh, Pa. Apr. 25-26, 1949.

SOUTHERN MACHINERY & METALS EXPOSITION. Atlanta, Ga. Apr. 25-28, 1949.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Oil & Gas Power Div. conference. Chicago, Ill. Apr. 25-29, 1949.

ASSOCIATION OF IRON & STEEL ENGINEERS, spring meeting. Baltimore, Md. May 2-3, 1949.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. New London, Conn. May 2-4, 1949.

AMERICAN FOUNDRYMEN'S SOCIETY, annual convention. St. Louis, Mo. May 2-5, 1949.

ELECTROCHEMICAL SOCIETY, spring meeting. Philadelphia, Pa. May 4-7, 1949.

AMERICAN MANAGEMENT ASSOCIATION, annual packaging exposition. Atlantic City, N. J. May 10-13, 1949.

INSTRUMENT SOCIETY OF AMERICA, spring meeting. Toronto, Canada. May 12-13, 1949.

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS, spring meeting. Detroit, Mich. May 19-21, 1949.

SOCIETY OF THE PLASTICS INDUSTRY, INC., national meeting. Chicago, Ill. May 26-27, 1949.

Molybdenum . . .

for all uses

THE MELTER KNOWS . . . . .

THE experienced melter knows he can depend on Molybdenum additions for uniform effects as calculated. He knows the customer can depend on the higher physical properties that Molybdenum adds. His comfortable assurance in the use of so trustworthy an agent is good to have. As a supplier of Molybdenum, Tungsten, and Boron, the Molybdenum Corporation is glad to be consulted at any time.

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Works: Washington, Pa.; York, Pa.

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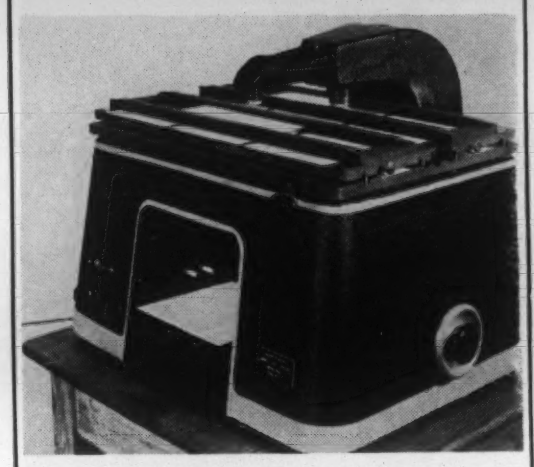
Convenience and Accuracy in Quantitative

SPECTROCHEMICAL ANALYSIS



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5. **High Speed:** Controls are immediately at hand. An operator can readily photometer as many as 5 lines per minute.
6. **A Wide Field of View:** The master spectrum covers 20mm, 100A at 5 A/mm.
7. **Precise Linear Measurement:** A scale can be supplied to read to .01mm.

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National Bureau of Standards (2 instruments)
Watertown Arsenal—M. I. T. Lab.
Indiana University
Dow Chemical Company
M. I. T.—Geology Department
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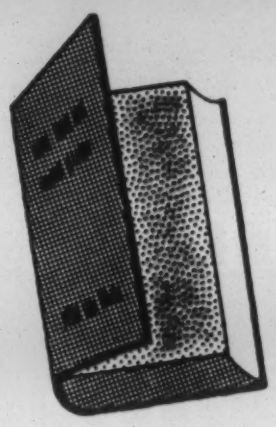

BOOK REVIEWS

Engineering Metals and Alloys

ENGINEERING METALS AND THEIR ALLOYS. *By Carl H. Samans. Published by Macmillan Co., New York, 1949. Cloth, 6½ x 9½ in., 913 pages. Price $7.50.* This excellent book is designed to provide a background of metallurgy for all technical men who have to use metallic materials, as well as to serve as a college-level textbook. Production metallurgy, physical metallurgy, and engineering metallurgy are adequately treated in balanced fashion, and the book seems completely up-to-date and authoritative.

The engineering metals are classified from an application rather than from an alloy viewpoint.

Titles of the chapters are: General Characteristics of the Metallic Engineering Materials; The Pure Metal; Metallurgical Methods; Production of the Metals—Magnesium, Aluminum, and Zinc—From Their Ores; Production of Pig Iron and Cast Iron; Iron and Steel Making; Production of the Metals—Copper, Nickel, Lead, and Tin—From Their Ores; Theory of Alloys, Principles of Heat-Treatment; Shaping and Forming the Metallic Materials; Corrosion, Its Effects and Control; Protecting Metals Against Corrosion; Alloys Used Largely Because of Ease of Fabrication; Pipe, Tubing, and Castings Resistant to Water Corrosion; Alloys Resistant to Chemical Corrosion and the Action of Heat; Alloys for Applications Requiring High Strength and Toughness; Alloys Resistant to General Wear and Abrasion; Tool Materials; Bearing Alloys; and Alloys Used Because of Their Special Physical Properties.

Other New Books

LIGHT ALLOYS IN THE FOUNDRY (LA FONDERIE DES ALLIAGES LEGERS). *By R. Perret. Paper, 6½ x 9½ in., 165 pages. Price 680 fr. In French.* Light alloy castings, melting, heat treatment, and foundry defects are discussed.

JIGS AND FIXTURES—REVISED FIFTH EDITION. *By F. H. Colvin & L. L. Haas. Published by McGraw-Hill Book Co., New York, 1948. Cloth, 6½ x 9¼ in., 410 pages. Price $4.50.* Data on design and use of jigs and fixtures are given.

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The Last WORD

by **FRED P. PETERS,** *Editorial Director*

A V.P. for Materials

We have a lot more respect for vice presidents now that somebody has found a really good use for them. Radio Corp. of America has actually put one of them to work by placing him in charge of a Materials Department. The "lucky" man is Vincent de Paul Goubeau, who has been director of materials for RCA Victor Division since 1945 and has now been elected vice president in charge of the Division's Materials Department.

This materials engineering field is really making progress: first a magazine, then a full college curriculum, and now a vice president. First thing you know there'll even be plenty of materials.

The Pigs' Tale

Many of us must remember the bedtime routine of counting our baby toes that began: "This little pig went to market. . . ." Today's little tale is about pigs, all right—pigs of metal—but the purpose of *this* one is to awaken rather than to put you to sleep.

For the past several years buyers of metals, especially, let their raw material inventories increase freely. Most materials were relatively scarce and if an extra ton or two could be obtained now it might prevent a tight situation some time later. Also, metal prices were gradually (not always so "gradually," at that) rising, and this provided a practical incentive to acquire added stocks before the price went up again.

Comes now a strange, and upsetting situation. Some metal prices are falling and others are expected to recede. A "disinflation" (if you'll pardon the expression) is underway in raw material prices. No one can be certain that prices will ever be higher; many people are sure they will eventually be much lower.

Therefore, large raw material inventories are now as embarrassing as a letter from a Russian relative. Indeed, some inventories are today considered "large" which in 1947 were referred to as "hand-to-mouth." Purchasers today reject as "still too high" metals at prices they prayed for a year ago. The purchasing agent with the big entertainment expense account of 1946 is now getting it all back from the metal sales people, who believe the golden rule should also apply to lead and zinc (and maybe even copper by the time this is published).

Of course, all this was bound to occur sooner or later. Maybe it's good to complete the readjustment as soon as possible. But one thing is sure: The buyer's market is just around the corner, if indeed it's not already here, and those who want to stay with it may have to take a few refreshers in how to do it, after all these years.

Certainly the days of just sitting back and letting the customer worry are over. We always did have a hunch that, in the end, it was the little pig who went to market that had the roast beef, and the one who stayed home that had none!

Epitath

Oh pray for this soul,
Which no body hath;
He got pickled and bathed
In the pickling bath.

The Chambersburg "Air Lift"

The Berlin "air lift," which still has the drop on the Russians' blockade of that city, was not the first air lift, by any means. The Ceco-Drop hammer of Chambersburg Engineering Co. employs what the company two years ago called the air lift principle to lift the ram. In other words, the hammer and Ceco brought the air lift to Chambersburg long before the hammer and sickle forced it on Berlin. [Ouch!]

Appendix for April

Stronger powder metallurgy parts are one of the field's big needs, says Irving Donohue of Presmet (Worcester, Mass.), and his shop is specializing in strong brass parts and iron parts "impregnated" with copper alloy to increase density and mechanical properties. For high shear strength many parts are made with steel inserts. Chief fascinator (for us, anyway): metal powder molds for plastic false teeth, now being mass-produced for assembly into dentures by the dentists themselves. . . .

Now is the time to send congratulations to Vincent Lysaght of Wilson Mechanical Div., who has just given birth to a bouncing baby book "Indentation Hardness Testing," out of Reinhold. It is the last word on the principles and practice of hardness testing (Rockwell, Brinell, Scleroscope, etc.) with sections on nonmetallics as well as metals. . . .

And send some orchids, too, to Carl Samans, now with Standard Oil of Indiana, in Chicago, for his extraordinary new text "Engineering Metals and Alloys," published by Macmillan. This is evidently Macmillan's competent answer to Frank Sisco's "Modern Metallurgy for Engineers" under the Pitman imprint, widely used in college courses. A new idea in metal books will be N. E. Woldman's "Materials Engineering of Metal Products," to be published by Reinhold later this year, which will analyze the specific materials problems of several widely used products—gears, bearings, electrical parts, lightweight equipment, high-temperature components, etc. . . .

Alex Squire of Westinghouse's Materials Engineering Dept. in E. Pittsburgh cried long and hard on our shoulder recently about the difficulty in finding just-graduating recruits who know their technical stuff, and who are eager to start on some rung of the ladder below the top two or three. And in the same area Lou Carapella of National Lead's Fellowship at Mellon Institute, cited the need for orientation to the adult professional and business world as the young college graduate's greatest need. We think Carapella has the formula for the problem distressing Squire—but it's up to our educators to provide the answer. . . .